DOCTOR OF PHILOSOPHY

Investigating sharing skills in children with autism spectrum conditions through participatory research

Menzies, Rachel

Award date:
2012

DOCTOR OF PHILOSOPHY

Investigating sharing skills in children with autism spectrum conditions through participatory research

Rachel Menzies

2013

University of Dundee

Investigating Sharing Skills in Children with Autism Spectrum Conditions through Participatory Research

Rachel Menzies

Doctor of Philosophy

University of Dundee

2012

Acknowledgements

First and foremost, I would like to thank the schools, NHS organisations and individuals who participated in the research contained within this thesis. Your contribution was invaluable and I would not have been able to complete this work without you. I know many of you have used your own personal time to contribute and for this I am especially grateful.

I am indebted to my supervisors, Prof Annalu Waller and Dr Helen Pain who have provided guidance, advice, friendship and support. Thanks must also go to the staff of the University of Dundee, in particular those in the AAC Research Group, who have been a ready source of advice and patience for the last four years.

I would like to acknowledge the financial support of ESRC who funded this work. In addition, the academic and research staff working on the Echoes project have offered support, assistance and guidance. You have always been willing to offer advice and this has been crucial in shaping the direction of my research.

Finally, I must express my gratitude to my family and friends for their support and much needed procrastination. I couldn't have done it without your love, encouragement and cooking.

Declaration of the Candidate

I declare that I am the author of this thesis; that all references cited have been consulted by me; that the work of which this thesis is a record has been done by myself; and that this thesis has not been previously accepted for a higher degree.

Rachel Menzies

Declaration of the Supervisors

We declare that Rachel Menzies has satisfied all the terms and conditions of the regulations under Ordinances 12 and 39, and has completed the required terms of research to qualify in submitting this thesis in application for the degree of Doctor of Philosophy.

Prof. Annalu Waller

Dr. Helen Pain

Table of Contents

Table of Figures

Table of Tables

Associated Publications

Menzies, R., Waller, A., Pain, H. (2011). Peer Interviews: An adapted methodology for contextual understanding in User-Centred Design. Poster, *In Proceedings of the 12th International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS)* (Dundee, UK, October 24 – 26, 2011).

Menzies, R. (2011). Developing for Autism with User-Centred Design. Student Research Competition, *In Proceedings of the 12th International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS)* (Dundee, UK, October 24 – 26, 2011).

Porayska-Pomsta, K., Frauenberger, C., Rajendran, T., Smith, T., Pain, H., **Menzies, R**., Foster, M., Alcorn, A., Wass, S., Bernadini, S., Avramides, K., Keay-Bright, W., Chen, J., Waller, A., Guldberg, K., Good, J., and Lemon, O. (2010).Developing technology for autism: an interdisciplinary approach. *Personal and Ubiquitous Computing* 16(2), pp117-127**.**

Menzies, R., Waller, A., Pain, H. (2010). Promoting sharing behaviours in children through the use of a customised novel computer system, Doctoral Consortium, Poster, *In Proceedings of the 11th International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS)* (Orlando, FL, USA, October 25 – 27, 2010).

Menzies, R., Waller, A., Pain, H. (2010). The provision of a learning environment for social communication and interaction in children with Asperger Syndrome and users of AAC. *14th Biennial Conference of the International Society for Alternative and Augmentative Communication (ISAAC)* (Barcelona, Spain, July 24 – 29, 2010).

Abstract

For most children, appropriate social skills and behaviours can be learned through observation and imitation of adult behaviour in social environments (Bandura and Walters 1963; Rheingold, Hay et al. 1976). The importance of social and communication skills have long been emphasised as the basis of learning by all children (Piaget 1962; Scottish-Executive 2004). One of these skills, sharing, is a "prosocial skill associated with the development of positive social relationships" (DeQuinzio, Townsend et al. 2008).

Affecting more than 500,000 people in the UK (National Autistic Society 2007), Autism Spectrum Conditions (ASC) are a collection of developmental disorders of varying severity, with behavioural manifestations changing with the severity of the disorder and age of a particular individual. ASC includes established difficulties in social interaction, social communication and a rigidity of behaviour and thought (Wing and Gould 1979; Pimley and Bowen 2006).

Sharing skills are an area of difficulty in Autism Spectrum Conditions, currently addressed by teachers within the educational setting. However, thus far few projects have been designed to promote the generalisation of these social skills. In addition, work in this area is typically with higher-functioning individuals with Asperger Syndrome or educated in a mainstream schooling environment. Limited work has been conducted with lower functioning individuals with additional learning disabilities. There is also a lack of interventions that have been designed using a user-centred participatory research approach.

In order to address this need, a computer system has been developed to support children with Autism Spectrum Conditions in the acquisition of sharing skills, and provide opportunities for the subsequent generalisation of these behaviours. The research involved devising ways to involve stakeholders in the design and development of the system. An evaluation of the final

prototype was carried out in a special-educational location with a group of low-functioning children with Autism Spectrum Conditions.

The results suggest that technology can be a useful vehicle to allow opportunities for children with Autism Spectrum Conditions to develop their sharing and social interaction skills. Use of the sharing tool shows some improvement in the participants as well as some transfer of knowledge and skills into different situations. This indicates that the involvement of practitioners and children, both with and without Autism Spectrum Conditions, in the design process has resulted in the development of a useful technology system with possible future applications in the education setting.

Chapter 1. **Introduction**

Autism Spectrum Conditions are a collection of developmental disorders of varying severity, with behavioural manifestations changing with the severity of the disorder and age of the individual. Symptoms appear in the first three years of life and continue in some form throughout life into adulthood (Baron-Cohen, 1995). Symptoms include difficulties in social interaction and communication and a rigidity of behaviour and thought (Wing and Gould, 1979, Pimley and Bowen, 2006). Sharing is a noted area of difficulty for those with Autism Spectrum Conditions (Attwood, 2006). However, there is a lack of current interventions allowing the exploration and development of sharing skills. Within the literature, there are studies focussing on developing the core skills of joint attention and theory of mind, but there is only limited work being conducted into higher level social skills, such as sharing.

This research aimed to develop a tool to assist children with Autism Spectrum Conditions in learning about and developing sharing skills. Conducted within the Echoes project[1], the tool was designed with input from practitioners and children, both with and without Autism Spectrum Conditions. The evaluation of the tool made use of practitioner input following participatory research methodologies.

1.1 The Echoes project: setting the context

This thesis was conducted as part of the Echoes project. The Echoes project has developed a Technology Enhanced Learning (TEL) environment that aims to assist children aged 5-7, both TypicallyDeveloping (TD) and with Autism Spectrum Conditions (ASC), to increase their awareness of others through their exploration of the social skill of Joint Attention in a safe,

[1] The Echoes project (http://www.echoes2.org) was funded by the Economic and Social research Council, UK and Engineering and Physical Sciences Research Council, UK under the Teaching and Learning Research Program – Technology-Enhanced Learning, grant number: RES-139-25-0395.

relaxing and predictable setting. Designed and developed in a user-centred and multi-disciplinary environment, the Echoes system allows children to interact with a 3D character named Andy within a ‘sensory garden’ (see figure 1). This is a multimodal environment where children can discover the properties of objects in order to complete scenarios; for example, turn taking with Andy to grow flowers in the garden. Children interact with the system through a large (42”) touch screen. The learning environment has been designed to encourage interaction that is structured and slow, in order that the child is able to focus well and process the information given.

Figure 1: Echoes screenshot

The research reported in this thesis was related to and influenced by the work conducted within Echoes. The focus remained on social skills, but while Echoes focussed on turn taking and joint attention, this work has focussed on the skill of sharing. The influence of the Echoes project on this work includes the hardware (a 42” touch screen) and a participatory design focus. In addition, involvement with the Echoes project has given the researcher a firm

grounding in the area of social skills research, while providing both training opportunities through working directly with participants and access to practitioner networks. Some activities conducted within the Echoes project have influenced the direction of this work, and this is highlighted within the text where appropriate. Additional activities were developed as part of the PhD project, specifically devising ways to enable to full involvement of relevant stakeholders by catering to their individual needs and abilities.

1.2 Aims of this thesis

This research aimed to improve and allow the exploration of sharing behaviours in children with Autism Spectrum Conditions. Participatory design has been shown to be helpful in the development of complex software that is functional and usable. It involves the early and continual involvement of end users and associated stakeholders. This is challenging when working with children with Autism Spectrum Conditions, due to the social difficulties they experience. This thesis aims to investigate the benefits of participatory design with this user group as well as associated stakeholders.

The research questions proposed are:

1. ***Can social skills, in particular sharing, be improved in Autism Spectrum Conditions through the use of a computer-based tool designed specifically to support this?***

2. ***Do any improvements, i.e. knowledge or skills, carry through to a wider social context?***

3. ***How can children with Autism Spectrum Conditions participate successfully in the design process of this system and what are potential outcomes of this?***

4. ***What can practitioners contribute to the design process and what is the impact of this?***

5. ***What do practitioners learn through contributing to the research evaluation?***

1.3 Contribution to knowledge

This project had two aims. A tangible outcome of the project was to be the production and evaluation of a prototype system. The primary purpose of the project, however, was the development of requirements gathering methodologies and the meaningful involvement of the end users and associated stakeholders in the design and development of prototypes. The software developed is an implementation of this design, the testing of which focussed, at least in part, on the potential successes of the design in terms of motivation and engagement of participants. Therefore, this thesis does report on the software which as developed, but the main focus is on the process of engaging children with Autism Spectrum Conditions in the design of the software as stakeholders in developing their own social skills.

The contributions to knowledge of this thesis are:

i. The creation of a software system that allows children with Autism Spectrum Conditions opportunities to explore sharing skills in a structured manner. The literature review highlighted a difficulty in the area of sharing in Autism Spectrum Conditions. Furthermore, little research has been conducted in the area despite the clear practical applications of the skill for learning and independent living. Technology has yet to be used to address this specific area of difficulty.

ii. How to achieve the genuine involvement of children with Autism Spectrum Conditions in research such as this. This thesis outlines the methods used to gain involvement of the end user group in research and design. Challenges in the involvement of this user group are acknowledged and considered.

iii. The implementation of participatory research methodologies in effectively involving practitioners in both the design of software and the subsequent research to evaluate effectiveness. This thesis reflects the active involvement of practitioners throughout the research including having a direct impact on the design of the sharing tool and the

analysis of its evaluation. This has grounded the development of the sharing tool in the best practice currently employed in education and ensures a direct route to the end user.

1.4 Thesis structure

Chapters Two and Three derive from the background reading for this thesis. Chapter Two begins by outlining the development of social skills and the implications of Autism Spectrum Conditions. This chapter continues by describing current interventions in assisting children with Autism Spectrum Conditions to become more aware of themselves and their own social interactions. Chapter Three then presents a detailed exploration of participatory design including a focus on children in general and those with Autism Spectrum Conditions.

Chapter Four presents a summary of the methodological and design principles adhered to in this thesis. In addition, the participants are described and their involvement in subsequent chapters and throughout the research is outlined.

Chapter Five outlines the exploratory studies undertaken to begin this research before scoping the research and listing the research questions that are addressed in the remainder of the thesis.

The main design of the sharing tool is described and discussed in Chapter Six. This chapter includes a consideration of the implications of involving children with Autism Spectrum Conditions and practitioners in the design process.

Following the production of low-fidelity prototypes, the formative evaluation of the sharing tool is presented in Chapter Seven. As a result of the work described in this chapter, a final outline of the sharing tool was presented in Chapter Eight.

Chapter Nine then documents the summative evaluation of the sharing tool, in which the success of the tool to engage children with Autism Spectrum Conditions in improving their sharing skills is evaluated through an in-depth exploration of two case studies.

The thesis concludes in Chapter Ten with a summary of the research, conclusions of studies contained within and proposed directions for future work.

Chapter 2. **Social skills**

In this chapter the typical development of social skills is considered. Subsequently, Autism Spectrum Conditions are introduced and specific social difficulties are explored. Strategies and interventions to aid in the development of these social skills in practical situations are identified and discussed with consideration of their use in research settings.

2.1 Typical social skills

In the typically developing population, appropriate social skills and behaviours can be learned through activities and experiences within social contexts (Prizant et al., 2008a). This includes observation and imitation of adult behaviour in social environments (Bandura and Walters, 1963, Rheingold et al., 1976, Ormrod, 1999) or on television (Coates et al., 1976). This observation and imitation develops through scaffolding by parents and caregivers from an early age (Carpendale and Lewis, 2006). Adults and other children model socially appropriate behaviours, which are strengthened though positive and negative reinforcement by parents and peers (Akers et al., 1979). For example, if one child in a classroom shows appropriate sharing behaviours then they may be praised or rewarded (positive reinforcement). Conversely, inappropriate behaviours are discouraged (negative reinforcement). At the early stages of development this is overt, but may become non-verbal or internal in nature as development progresses. This exhibits the behaviour as desirable and the child may repeat the behaviour in order to repeat the associated and sought-after consequences. An opportunity for incidental learning is also presented here, with other children recognising the action (sharing) and the desirable consequence (praise/reward), and endeavouring to display this same socially rewarding behaviour.

The importance of social and communication skills has long been emphasised as the basis of learning by all children (Piaget, 1962, Scottish-Executive, 2004). A lack of social competency can have detrimental effects in later life, resulting in significant difficulties in daily living, academic achievement, and poor adult outcomes related to language ability (Baldwin and Moses, 1996, Tomasello, 1995), employment and social relationships, such as making and maintaining friendships (Klin and Volkmar, 2003, Howlin, 2003, Parsons et al., 2000, Carter et al., 2004) and peer isolation (Chamberlain, 2011).

2.2 Autism spectrum conditions

The recognition of Autism Spectrum Conditions has followed an evolutionary path from original work in the literature and observations by Leo Kanner (1943) and Hans Asperger (1944 [1991]) through to present-day diagnostic criteria and research. Affecting more than 500,000 people in the UK (National Autistic Society, 2007), Autism Spectrum Conditions (ASC) are a collection of developmental disorders of varying severity, with behavioural manifestations changing with the severity of the disorder and age of a particular individual. Symptoms appear during the first three years of life and will continue in some form throughout life into adulthood (Baron-Cohen, 1995), often meaning that individuals with Autism Spectrum Conditions will be cut off from learning with and through other people in ways that their typically developing peers are not (Jordan and Jones, 1999).

Conditions on the spectrum range from classical autism, generally considered to be the ‘most severe’, to Asperger Syndrome and High Functioning Autism as the ‘least severe’. The ranges of symptoms seen along the autism spectrum differ greatly, even within diagnostic criteria, reflecting the heterogeneity of the conditions seen (Geschwind and Levitt, 2007). For example, in classical autism, the individual is severely impaired in terms of their learning, physical and intellectual abilities while, in Asperger Syndrome, the

individual shows social and communication impairments with no observed deficit in language and cognitive abilities (Attwood, 2006).

In addition, there is a Broader Autistic Phenotype, which many consider as part of the spectrum. This is not a diagnostic criterion per se, but is representative of individuals who display similar traits to those of autism, albeit to a lesser degree (Losh and Piven, 2007). Individuals displaying these traits are often very successful in their chosen field of work. This Broader Autistic Phenotype was recognised by Kanner (1943) as being prevalent in the families of children he documented; the first indications that Autism Spectrum Conditions may have a genetic basis. Hans Asperger (Asperger, 1944 [1991]) independently noted the occurrence of these traits in family members. Currently, the presence of a Broader Autistic Phenotype is a source of dispute in the literature (e.g. (Scheeren and Stauder, 2008)) with the source of friction often being the lack of successful diagnostic tools.

Across the autism spectrum, the typical trajectory of development is compromised. The first indicator of a future diagnosis is usually a lack of joint attention, defined as *"the capacity to use gesture and eye contact to coordinate attention with another person in order to share the experience of an interesting object or event"* (Bruner and Sherwood, 1983, Seibert et al., 1982). This includes, for example, pointing to an interesting item in the environment, such as a toy of interest. Another indicator is a lack of Theory of Mind; that is a lack of appreciation of the thoughts, beliefs and feelings of others (Baron-Cohen, 2000). This results in established difficulties in social interaction, social communication and a rigidity of behaviour and thought (Wing and Gould, 1979, Pimley and Bowen, 2006).

The aetiology of Autism Spectrum Conditions is, by and large, unknown, although it is widely believed that genetic factors play an important role. This was highlighted by Hans Asperger in his original paper (1944 [1991]), where three of his four cases had at least one parent whom he described as "eccentric" or "highly strung". Family studies (e.g.

(Ghaziuddin, 2005)) have reinforced this suggestion, with some specific chromosomes being identified as possible sites of genetic disruption (Ashley-Koch et al., 1999, Persico, 2001).

Other theories have included the identification of teratogens that increase risk during the first trimester of pregnancy, such as maternal rubella infection or ethanol (Arndt, 2005), or obstetric complication (Bolton, 1997). There has also been some considerable press coverage of the notion that the administration of the MMR (measles, mumps and rubella) vaccine may be a cause (Wakefield, 1998). This paper has since been refuted by a number of studies (e.g. (Hornig, 2008)), retracted by 'The Lancet' journal (Lancet, 2010) and effectively dismissed as a possibility.

2.2.1. Triad of impairments

The triad of impairments can map with many diagnostic schedules for Autism Spectrum Conditions (WHO, 1992) and are flexible in their manifestation in different individuals on the spectrum; individuals may display only a few or many symptoms in each triad to differing degrees of severity (Wing and Gould, 1979). Examples of such symptoms are shown in table 1.

Table 1: The triad of impairments (Wing & Gould, 1979)

Impairment	Social Interaction	Social Communication	Rigidity of thought and behaviours
Description	A difficulty in recognising the thoughts, feelings and emotions of others (Theory of Mind).	A difficulty understanding and utilising non-verbal cues, such as gestures, facial expressions, tone of voice and abstract language.	A difficulty in imagining social situations outwith an established routine; difficulty with engaging in pretend play.
Examples	Appearing rude or unresponsive, displaying absent or inappropriate eye contact, gestures and expressions, showing no spontaneous sharing of interest with peers or a perceived unwillingness to interact with and befriend peers.	Literal/functional conversations. A difficulty in expressing themselves in a subtle way. Use of unusual or repetitive language; finding it difficult to initiate and sustain a conversation.	Play is functional, fascination with object parts, pre-occupation with narrow interests. Anxiety when changes are made to routine or environment.

2.2.2. Joint attention

Joint attention is a cluster of behaviours that share the common goal of communication with another person about a third entity (an object, for example) in a non-verbal way (Bruinsma et al., 2004). This triadic co-ordination between two people and an object (Charman, 2003) can include eye gaze alternation, vocalisations and gesturing. There are two components to joint attention; the initiation of joint attention (by seeking the attention of the other person) and responding to these initiations from others. Gaze alternation, a key component of joint attention, typically develops from around the age of 11 months (Bates et al., 1975). Work by Bakeman and Adamson (1984) has shown the development of joint attention, with increasing frequency and duration of co-ordinated joint attention increasing with age at 3-month intervals between 6-18 months of age.

The emergence of joint attention is closely related to the development of "intentional communication" (Tomasello, 1995), and is also related to the later development of a Theory

of Mind (Camaioni, 1992). This begins around 9 months of age (Bates, 1979) with alternating eye gaze, leading to gesturing and/or vocalisations and resulting in vocalisations that more closely resemble speech patterns and verbal language. The process of development begins with the understanding that another person can be a means to achieve a personal goal, and that sending a signal to that person can affect their actions (Bates et al., 1975, Prizant and Wetherby, 1987). This is at odds with the person-object view (Prizant et al., 2006), whereby individuals with Autism Spectrum Conditions view people as objects rather than possible social entities.

A lack of effective joint attention behaviours is a core deficit in Autism Spectrum Conditions (Charman, 2003, Leekham et al., 2000). Comparing typically developing children to those with Autism Spectrum Conditions, the most atypical behaviour of the Autism Spectrum Conditions group is that of Joint Attention (Mundy et al., 1986). Individuals with Autism Spectrum Conditions often have severe difficulties in eye contact, both referentially (as in Joint Attention) and in the wider context of simply looking at other people (Bruinsma et al., 2004, Stone, 1998). It is known that those with Autism Spectrum Conditions look less at the eye region and more at the mouth, body and objects than control participants (Klin et al., 2002a, Klin et al., 2002b). Control participants were noted as fixating on the eye regions twice as often as those with Autism Spectrum Conditions. Further, when looking at the eye region, a person with Autism Spectrum Conditions is less able to read the social or emotional meaning portrayed than their typically developing peers (Baron-Cohen et al., 2001). So, through looking at the eye region less frequently and having difficulty when doing so, those with Autism Spectrum Conditions may miss changes of expression and find it more difficult to attribute meanings to these (Klin et al., 2002a).

Joint Attention is an early indicator of Autism Spectrum Conditions, and is often the earliest noted manifestation of autistic behaviours (Baron-Cohen, 1989). Studies have compared

first birthday home videos of both typically developing children and those with Autism Spectrum Conditions (Osterling and Dawson, 1994, Osterling et al., 2002). It was noted that the frequency and duration of looking at other people was the single best predictor of a later diagnosis of an Autism Spectrum Condition.

In addition, the lack of Joint Attention seen in Autism Spectrum Conditions is correlated with language delay (Loveland et al., 1988, Mundy et al., 1986), as children with Autism Spectrum Conditions frequently develop language later than their typically developing peers and at a slower rate (Lord and Paul, 1997). There is a strong correlation between Joint Attention in young children with Autism Spectrum Conditions and language ability 10 years later (Lord et al., 2003, Sigman and Ruskin, 1999). The acquisition of Joint Attention is considered to be a precursor of understanding both what has been said and the communicative intent of others (Tomasello, 1995).

2.2.3. Theory of mind

In Autism Spectrum Conditions, social interaction and communication are established areas of difficulty (Travis et al., 2001). In order to communicate appropriately, the needs, desires and opinions of the communication partner must be determined and analysed with respect to the given situation (Doherty, 2009).

Theory of Mind is the ability to recognise the thoughts, beliefs, desires and intentions of others such that one can make assumptions and predictions about their future behaviours (Baron-Cohen, 1995, Attwood, 2005, Dennet, 1987). This concept has been extensively studied in the development of both typically developing children and those with Autism Spectrum Conditions. Reduced and/or delayed Theory of Mind abilities are seen in Autism Spectrum Conditions (Baron-Cohen et al., 1985). This is termed “mind blindness” by Simon Baron-Cohen (1995), often manifested as a lack of empathy with others (Gillberg, 2002). It

is proposed that a well developed Theory of Mind is the foundation of human social interaction (Klin, 2000) and that the understanding of the perspective of others is vital to social reciprocity and the development of friendships (Slaughter et al., 2002).

A neurological basis has been proposed to explain the impaired or delayed Theory of Mind abilities seen in Autism Spectrum Conditions (Castelli et al., 2002). It was noted that specific brain regions, namely the prefrontal cortex, superior temporal sulcus and temporal poles, mediated the attribution of mental states. These brain areas are established sites of activity in relation to the orchestration of thoughts and actions with regard to an individual's internal goals, and the perception of eye gaze (Carter, 2009), a crucial difficulty experienced in Autism Spectrum Conditions (Pelphrey et al., 2005). This difficulty in following the eye gaze of another person, with or without finger pointing, is often one of the first indicators of a diagnosis of an Autism Spectrum Condition (Ornitz et al., 1997).

There are currently a number of methods for determining a person's ability in relation to Theory of Mind. The provision of a social situation (e.g. as a story or storyboard) is common. A series of comprehension questions are then asked to determine the thoughts, feelings and emotions of characters in the story, such as "Strange Stories" by Francesca Happe (1994), aimed at children aged 4-12 years. It is found that individuals with Autism were impaired in providing context-appropriate mental state explanations for non-literal utterances within the stories. The performance of individuals on these naturalistic stories was closely linked to other Theory of Mind tests such as test of first-order and second-order belief tests (Wimmer and Perner, 1983, Baron-Cohen et al., 1985), although these can have a ceiling effect at the developmental age of 6 years (Perner and Wimmer, 1985).

Theory of Mind assessments are typically verbal in nature (Doherty, 2009), as is the case with Happe (above), which may lead to a false positive in assessment scores since verbal abilities are usually high in Autism Spectrum Conditions. Therefore, the assessment scores

may not accurately reflect social functioning. In addition, the explicit nature of Theory of Mind tests, in which comprehension questions can be specific to the given situation, does not allow for the ambiguity encountered in reality. Theory of Mind testing is frequently administered in a laboratory setting, which is not a good representation of the child's typical interaction behaviours (Lazar et al., 2010). The acquisition of a social behaviour may be different from its performance, with the learned skills only manifesting on certain occasions or under certain circumstances (Eisenberg and Mussen, 1990). Further, the dichotomous nature of measures (either successful or not successful) means that the quality of the person's abilities is not taken into account.

Thus, an individual with some difficulties may appear to have successful social abilities following the assessment, but have difficulties in reality. Klin (2000), has quantified the difficulties in Theory of Mind through implementation of the Social Attribution Task (SAT), first developed by Heider and Simmel (1944). This comprised a series of cartoon animations with "characters" in the form of 2D geometric shapes (e.g. square, triangle). In this study, adolescents with Autism Spectrum Conditions, specifically Asperger Syndrome, were asked to describe the actions and feelings of the animated geometric characters and the narrative answers were marked on a Likert scale across seven indices of social functioning. The subjects with Asperger Syndrome identified only 25% of the social elements identified by the control subjects (college students), and with less social sophistication. The personality attributes given were more simplistic and lesser in number, and were focused on physical aspects, e.g. bouncing, compared with the anthropomorphic words used by the control subjects to describe actions and feelings, such as "chasing" or "frustrated". The ability of individuals with Autism Spectrum Conditions to spontaneously anthromorphise was also shown during prototyping design research by Frauenberger et al (2011), whereby children attributed intentionality to abstract shapes during a bubble-popping activity on a large touch-screen. This ability was not specifically measured in this study, but appears to be a more

positive result than that gained in the Klin study, likely due to the more natural social environment on interaction in which the anthromorphisis occurred.

Many of the descriptions given during the Social Attribution Task by the adolescents with Asperger Syndrome were literal in their interpretation of events within the animation and did not show the ability to attribute social meanings. This literal interpretation of events can be particularly problematic when dealing with metaphors and figures of speech, common in the English language (e.g. *"ace up their sleeve", "skeleton in the closet"*) (Happe, 1995). Within the typically developing population, there is an understanding of the incongruence between facial expressions, tone of voice and context in order to determine differences in metaphors, sarcasm and humour (Reddy et al., 2002, Tager-Flusberg, 2000). In Autism Spectrum Conditions, individuals often cannot apply these concepts, which enable their typically developing peers to extend beyond a literal interpretation.

In addition, the concepts of honesty and deception require advanced Theory of Mind abilities (Dissanayake and Macintosh, 2003, Baron-Cohen, 2000), with typically developing children able to identify situations whereby an adult does not have sufficient knowledge of an incident and so can use deception and dishonesty to avoid consequences for inappropriate behaviours or actions. This ability to employ deception tactics typically occurs around four years of age (Sodian et al., 1991). However, in Autism Spectrum Conditions, individuals have difficulties determining the beliefs and knowledge of others (Baron-Cohen, 1995). As a result, children with Autism Spectrum Conditions can be remarkably honest (Attwood, 2005) and may only begin to employ deception tactics as late as adolescence when they have made sufficient developments in Theory of Mind. Typically, deception may also be employed as a "white lie" to avoid causing offence to others. Again, this is based on Theory of Mind abilities; understanding that the truth may upset someone and adjusting your interaction accordingly in order to avoid upsetting that person. Individuals with Autism

Spectrum Conditions will likely develop this concept of deception much later in their development, which can often lead to the child with Autism Spectrum Conditions appearing to be deliberately rude or obnoxious.

Another area of specific difficulty related to Theory of Mind is that of problem solving (Myles, 2004). When faced with a problem, typically developing children have an understanding that those around them may be able to provide assistance when it is required. However, for those with Autism Spectrum Conditions, the lack of understanding of the opinions and knowledge of others is often not sufficiently developed to warrant such ability (Baron-Cohen, 1995). As a consequence, children with Autism Spectrum Conditions usually will not actively seek help to solve problems (Reichle et al., 2008, Williams, 1989). This particular issue is addressed by Social Stories (see Section 2.3.1), with the explicit indication of whom the child should consult for help or advice.

Due to these established difficulties, the learning of appropriate social communication and interaction behaviours takes a different trajectory in those with Autism Spectrum Conditions compared to the typically developing population (Gustein and Whitney, 2002, Pennington et al., 2007). Rather than determining the social appropriateness of behaviour through the actions and reactions of others, those with Autism Spectrum Conditions are explicitly taught appropriate social behaviours in relation to specific circumstances in order that these learned behaviours may be generalised and applied in future situations. For this reason, the acquisition of the prosocial behaviour may be different from its performance (Eisenberg and Mussen, 1990). An individual may have learned a particular prosocial response, but the behaviour may be manifested only on certain occasions or in certain circumstances. This lack of generalisation is typical in Autism Spectrum Conditions (Gena et al., 1996, Attwood, 2006, Silver and Oakes, 2001) and is one that is addressed frequently in therapy, education and within the literature.

2.2.4. Prevalence

The prevalence of Autism Spectrum Conditions has been investigated through epidemiological studies. The most well known of these, a large-scale study within a population of children aged 8-10 years old (Baird, 2006), reported the prevalence as 116.1 per 10,000. reasonable within the literature as prevalence estimates. The National Autistic Society (2007) has estimated that over 500,000 people in the UK have an Autism Spectrum Condition, with approximately 133,000 of these being under 18. This means that 1 in 100 people in the UK are currently affected by an Autism Spectrum Condition (National Autistic Society, 2008).

Autism Spectrum Conditions affect boys more often than girls, with the ratio of males to females being quantified as 3:1 (Baird, 2006), although Raznahan and Bolton (2008) have reported a ratio of 4:1. This ratio is substantially increased when considering specific conditions such as Asperger Syndrome, with 10:1 being the typical ratio given, based on clinical experience (Gillberg and Gillberg, 1989).

2.2.5. Diagnosis

The diagnosis of an Autism Spectrum Condition may occur at any stage of life. However, a timely diagnosis is important, as an early diagnosis and the subsequent provision of appropriate services and therapeutic interventions improves adult outcomes (Ozonoff and Cathcart, 1998), with more adults now achieving greater levels of independence than in previous years (National Research Council, 2001). In order to diagnose an Autism Spectrum Condition, the skills, abilities and needs of the individual are assessed through the use of assessment tools. There is no definitive “symptom” of an Autistic Spectrum Condition; rather it is a collection of symptoms that may or may not be present in all individuals and most certainly overlap between the different disorders along the spectrum. There are a

number of diagnostic manuals available as well as a number of tools designed to help practitioners arrive at an appropriate diagnosis.

Two main diagnostic manuals are used; the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) (APA, 1994) and the International Classification of Diseases and related Health Problems (ICD-10) (WHO, 1992). In order to diagnose an Autism Spectrum Condition, a clinician will utilise assessment tools described below, comparing the results to a categorised collection of signs or symptoms. In the case of the DSM-IV, displaying over a given number of those symptoms listed will result in a diagnosis of an Autism Spectrum Condition. Using the ICD-10, the clinician will determine which category of symptoms is most applicable to the individual.

There are a number of tools in existence that are used to support the diagnosis of an Autism Spectrum Condition. The role of such tools is to assist the clinician in making diagnostic decisions based on behaviours exhibited by individuals in a variety of situations and contexts.

The Social Communication Questionnaire (SCQ) is a measure of symptomology of Autism Spectrum Conditions based on the Autism Diagnostic Interview (LeCounteur et al., 1989) and is used to indicate the likelihood that an individual has an Autism Spectrum Condition (Rutter et al., 2003a). As a valuable screening tool, the SCQ can help to correctly identify individuals with a possible diagnosis of an Autism Spectrum Condition compared with other developmental disorders (Allen et al., 2007, Chandler et al., 2007). This can be useful in avoiding unnecessary further screening where possible. Diagnosis is not made on the basis of the SCQ alone, as there is no consideration of the onset of symptoms or the occurrence of symptoms across a variety of contexts. There are two forms of questionnaire, both of which take less than 10 minutes to complete. The lifetime form will provide an entire history, while the current form considers only the previous three months. The use of these in combination

over time can assess the development of behaviours and assess areas of improvement or regression. In addition, there is no special training required to complete the SCQ.

The SCQ is a questionnaire comprising of 40 yes/no answer questions such as *"Does she/he ever have any interests that are unusual in their intensity but otherwise appropriate for her/his age group (e.g., trains or dinosaurs)?"*. Once completed by a parent or primary caregiver, the score is calculated by adding the responses given to indicate the likelihood that the individual has an Autism Spectrum Condition. The cut off score of 15 for the lifetime form has been validated in the literature by Berument et al (1999). The lifetime score can be used to begin the process of diagnosis or to confirm a diagnosis already given, while the current score can be used to assess progress or recent changes in behaviours. However, there is no provision of a framework to potentially improve this score; the tool is used primarily for the purpose of recording the exhibited behaviours.

While there is no training required to complete the Social Communication Questionnaire (Berument et al., 1999), an experienced clinical interviewer typically conducts an Autism Diagnostic Interview – Revised (ADI-R) with a parent or caregiver in order to provide a diagnosis of an Autism Spectrum Condition (Rutter et al., 2003b, LeCounteur et al., 1989, Lord et al., 1994). The interview comprises 93 items focussing on language and communication, reciprocal social interaction and restricted, repetitive and stereotyped behaviours or interests. Responses are recorded and coded by the interviewer to determine a diagnosis. The ADI-R has been proven effective in differentiating autism from other developmental disorders (Lord et al., 1997, Lecavalier et al., 2003), but takes 1.5 and 2.5 hours to complete (Constantino et al., 2003). As a result, it is not frequently used in clinical settings and thus the clinical application of the results is ambiguous (Hall, 2010). This interview procedure is based on both historical and current behaviours in order to assess for

a diagnosis, but there is no specific consideration of how these behaviours have developed over time.

The ADOS diagnosis tool (Lord et al., 2000, Lord et al., 2001) can assist in diagnosis of Autism Spectrum Conditions across a range of developmental levels, language skills and ages. There are four semi-structured assessment modules available, each of which takes 35-40 minutes to complete. Only one module is used for one individual, conditional to their verbal abilities and chronological age. As a result, the assessment can be tailored to the appropriate developmental level for the individual. This is done by selecting the expressive language level of the individual; a unique yet crucial element of the ADOS in determining an appropriate diagnosis (Klein-Tasman et al., 2007). Sample naturalistic, social and communicative behaviours are obtained (Klin et al., 2007). Examples of interactions considered include free play, joint attention and the response to different emotions and behaviours exhibited by the individual administering the test. After the interactions are completed for the module, the ratings are compiled immediately and a diagnosis prepared using a diagnostic algorithm based on the DSM-IV (Klin et al., 2007).

Finally, the Pervasive Developmental Disorder Behavioural Inventory (PDDBI) is a standardised assessment of the responsiveness of an individual to interventions (Cohen et al., 2003) and so the current development of the individual is considered. A variety of opinions are sought, with the age-standardised scores being calculated for both parent and teacher ratings. Comprising 188 items, divided into 10 categories, completion of the inventory will take approximately 45 minutes for a parent or caregiver to complete, possibly outwith the clinical setting (Cohen and Sudhalter, 2005). The PDDBI has been favourably reviewed (e.g. (Cohen, 2003, Cohen et al., 2010)) but more recent work has suggested that the cut-off score could be altered to increase the effectiveness (Hall, 2010).

On-going assessment

In the assessment tools described above, the focus is on diagnosis through the consideration of the historical and/or current abilities of the individual. However, as the individual develops, they will often show varying symptoms and abilities (Howlin and Asgharian, 1999), at different times in different contexts. These assessment tools do not widely consider the on-going assessment of skills, which can be used to monitor educational and social progression and development. Whilst some tools (e.g. Social Communication Questionnaire (Rutter et al., 2003a)) allow for the consideration of recent behaviours, there is no focus on the development of these skills and abilities. One such approach that allows for both development and the associated continual assessment is SCERTS (Prizant et al., 2008a).

SCERTS (Social Communication, Emotional Regulation and Transactional Support) is a *"comprehensive multi-disciplinary approach to enhancing communication and social-emotional abilities of individuals with Autism Spectrum Conditions and related disorders"* (Prizant et al., 2008b). This is achieved through continual assessment and striving for the development of social skills, which progress through the social partner, language partner and conversational partner stage, as the development of language, vocabulary and interaction skills increase.

The SCERTS approach emphasises a co-ordination and collaboration of professionals (such as teachers and therapists), parents and family members. Parents and family members are considered to be experts in their own child's skills and difficulties. The implementation is systematic and semi-structured, but also must be flexible. In achieving this flexibility, it is individualised for each child, focussing on their own underlying capacities and learning styles. This allows for the incorporation of a variety of teaching practices and approaches. Some of these are described in Chapter Two.

The development of SCERTS has been based on recommended practices (Prizant and Rubin, 1999, Wetherby and Prizant, 1999), which correlate with those recommended by the National Research Council (2001):

- Directly address the core developmental challenges of children with Autism Spectrum Conditions.
- Based on current knowledge of child development, placing learning within the context of natural environments.
- Individualised to match a child's current developmental level and learning profile of strengths and weaknesses.
- Demonstrate a logical consistency between long-term goals and the teaching strategies to achieve these goals.
- Derived from a range of sources.
- Apply meaningful measures of progress and outcomes.

Within these practices, the focus is placed on the three main areas of consideration within the SCERTS model: Social Communication, Emotional Regulation and Transactional Support (Prizant et al., 2006). The goal of social communication is to assist the child in becoming an increasingly competent, confident and active participant in school and learning activities, such as playing with peers and sharing experiences. Providing the child with opportunities to engage in developmentally appropriate social communication is essential for a social understanding of daily experiences (Prizant et al., 2008a). This is achieved through a focus on learning objectives related to Joint Attention and the promotion of a communicative means, such as gestures, symbols or verbal communications. The goal of learning objectives related to emotional regulation is to provide the child with both opportunities and strategies to regulate their own emotional arousal by seeking assistance when required, strategies for self-regulating emotions and recovering from emotional

dysregulation where these strategies have failed. This can assist the child to maintain an optimal state of emotional arousal that matches the social demands of their environments (DeGangi, 2000), placed on a continuum from sleep to wakeful (Lester et al., 1995). Transactional support objectives provide learning supports such as the alteration of the environment in order that it is conducive to providing learning experiences, as well as supporting families and wider networks to set up the environment in suitable ways.

Where a SCERTS-based approach is utilised, children are frequently assessed through video observations in a variety of settings, after which the professionals, parents and family members agree upon a number of current learning objectives. These learning objectives are addressed using a variety of interventions that adhere to the recommended practices highlighted above. Continual assessment means that these learning objectives are frequently adjusted as appropriate, ensuring a continual focus on development across the areas of Social Communication, Emotional Regulation and Transactional Support.

2.3 Social skills interventions

Social development can have a greatly positive impact on the life of an individual, through the development of friendships and other reciprocal relationships, an identity of self and an awareness of others in relation to Theory of Mind (Lahno, 1995). Social skills in typically developing children are acquired through a combination of social learning, such as following instruction, observation and imitation. However, children with Autism Spectrum Conditions do not tend to respond well to traditional, primarily verbal, teaching strategies (Schreibman, 1988) such as abstract instruction and can have difficulty with observation and imitation due to a reduced Theory of Mind This has an impact on the development of social skills and, as a result, a great deal of expertise, time and effort has been invested in the provision of therapy to improve social skills in those with Autism Spectrum Conditions.

There have been a number of attempts to assist those with Autism Spectrum Conditions in developing these skills (e.g. (Rajendran, 2000, Bellini and Peters, 2008)). The basis of these therapies is to aid in the understanding of non-verbal communication and the provision of the hidden aspects of communication that typically developing individuals largely take for granted and develop unconsciously through scaffolding by parents and caregivers (Carpendale and Lewis, 2006). Children with Autism Spectrum Conditions have difficulty learning through traditional methods due to social, intentional and motivational difficulties (National Research Council, 2001). Therefore, communication groups play a major role in providing tailored therapy for individuals (e.g. (Wolfberg and Schuler, 1993)). Typically these groups will comprise between five and eight children working with at least one therapist, and will involve a variety of intervention methods such as role play, which provides opportunities to practice skills in a safe environment, group discussions, which allows for the sharing of information amongst the group and play activities. This provides an opportunity for the children to implement the skills they have learned. There is a focus on underlying social abilities throughout, such as appropriate eye contact (Baker, 2003). The structure of such sessions is determined by the age and ability of the participants, being such that the participants feel comfortable and confident in the environment. This can be achieved by implementing structure and familiar objects such as toys or objects of interest.

Despite the introduction of these therapies, there is no recognised best practice in social skills therapy. As a result, educators and therapists use a variety of techniques, often in combination, in order to ensure the fullest engagement from the children concerned. This increased rate of engagement has been identified as significant, as this is positively correlated with the development of social and communication skills (Libby et al., 1997, Thorp et al., 1995). There have been proposals within the literature that social skills interventions should be aimed at individuals who are higher functioning (Rao et al., 2008), but there are many documented cases where social skills interventions have been

implemented with lower functioning individuals on the Autistic Spectrum with positive results (Reynhout and Carter, 2009, Feinberg, 2002). Examples of therapeutic techniques include social stories (Gray, 2004), Comic Strip Conversations (Gray, 1994a), the Power Card (Gagnon, 2001) and video modelling (Scattone, 2008, Taylor et al., 1999).

2.3.1. Social Stories™

Social Stories™ were devised by Carol Gray (Gray and Garand, 1993, Gray, 1994b), to provide a tangible link to the missing (non-verbal) information in communication. Specific situations are considered with respect to relevant social cues and the perspectives of others. Possible solutions to the given situations are provided and the most desirable and appropriate responses are considered. These stories are typically written in the first person and are most often personalised to the needs and interests of the individual. This is because the narrow interests of a child with Autism Spectrum Conditions must be accommodated, taking into account the child's strengths and abilities (Gray, 1995). It is suggested that social stories are most effective when they are customised for individuals (Gray and Garand, 1993). In addition, the tone of the stories is positive and encouraging, intending to increase self-esteem and foster a willingness to accept suggestions of new approaches and to deal with new problems (Groden et al., 2006).

The purpose of social stories is to provide the information that is not recognised by those with Autism Spectrum Conditions, allowing them to use the information provided in the story to make decisions regarding the appropriate form of social interactions. However, care should be taken to ensure that the stories created are not prescriptive. Thus, Gray (1998, 2000) has set guidelines for the types of sentences (see table 2) that should be used in social stories and the relative ratios of each one. It was proposed that following these ratios would

result in the most effective type of social story being produced. The basic ratio proposed was 2-5 descriptive and/or perspective sentences for every 0-1 directive or control sentence.

Table 2: Sentence types from Gray (1998, 2000)

Sentence Type	Description	Example
Directive	Describes the desired responses to social situations and indicates (in positive terms) what he or she should try to do in the given situation.	"I will try to stand quietly in line"
Control	Statements written in consultation with the student, identifying strategies that may be used to recall information in the story and apply it to the situation.	"When people are walking slowly, I can think of snails. They also move very slowly."
Descriptive	Describe who, what, where, when or why of a situation. May describe a setting, environment or people involved.	"At my new school there are many children. The corridors are often busy and noisy."
Perspective	Describe the reactions and responses of others. Also, consider the reasons behind their responses and feelings.	"My teacher will be pleased if I share the toys at play time. She may give me a sticker when I do this."
Affirmative	Provide reassurance and/or emphasise an important aspect of the story.	"This is OK..." "It is important to listen to the fire marshals"
Co-operative	Indicate who can provide assistance in the given situation.	"If I can't find my size, I can ask a shop assistant to help me"

From this, the role of social stories in the development of Theory of Mind is clear. The perspective and co-operative sentences are particularly useful, with the information given in a way that is clear and concise. This provision of the "hidden", non-verbal information, such as the thoughts, feelings and beliefs of others, can be valuable in aiding the understanding of the opinions and intentions of other people, along with predictions of their future behaviours (Howley and Arnold, 2005). However, to date, there are no published studies that have examined whether and how social stories can improve Theory of Mind abilities using standardised tests, specifically focussed on Theory of Mind.

Due to the vast heterogeneity of symptomology observed in Autism Spectrum Conditions, the information within the story should be provided in a means that is comprehensible to the specific individual. For this reason, many different formats are used such as written, visual and auditory. Gray recommended that images should be used sparingly (1993). Since then, there have been many studies involving implementation using images (Crozier and Tincani, 2007), photos of the child (Dodd et al., 2008), multimedia (Sansosti and Powell-Smith, 2008, Hagiwara and Myles, 1999) and video modelling (Scattone, 2008). These have been widely successful, and images are used frequently in practice within schools and therapy locations.

Some evidence suggests that social stories are in improving social skills across a range of Autism Spectrum Conditions (e.g. (Thiemann and Goldstein, 2001)). These stories have been implemented across a variety of experimental designs and so the studies do not lend themselves to an immediate comparison. However, the gauged effectiveness as reported by parents and/or teachers across the varied implementations was available. There is no doubt that social stories are widely used, with one survey by Reynhout and Carter (2009) of teachers in special educational environments finding that all participants reported use of social stories in their classroom, and a very large proportion of these (93%) were deemed to have been effective within their context in which they were introduced. By and large, the teachers did not consider maintenance or generalisation and the vast majority of the stories failed to fall within the guidelines proposed by Gray for the construction of the stories. This is indicative that social stories reflect the heterogeneous nature of Autistic Spectrum Conditions. Indeed, 96% of respondents claimed to use individualised social stories, although they were primarily used as a part of a larger therapy program and were rarely used as a sole intervention. This is common within therapy and is seen in the literature, with many studies (e.g. (Dodd et al., 2008)) using a number of therapeutic interventions, and can

have implications in the analysis of the effectiveness of Social Stories since other interventions may be confounding factors.

Overall, within the literature, the effects of social stories are variable (Ospina et al., 2008). Social stories have been shown to be effective in a variety of settings such as at home or school (e.g. (Chan and O'Reilly, 2008, Lorimer et al., 2002)), but their use does not always result in a successful outcome. Ricciardelli (2006) found that the use of social stories did not result in significant measurable changes in social skills, although there were improvements and this study had only a small number of participants (n=3). Despite the apparent overarching success of social stories, there are some aspects that may be improved upon. The nature of social stories renders them non-interactive in nature. The story is laid out at the point of writing and does not allow for exploration by the child. Simply reading the story does not allow the child to experience and explore the social communications and interactions discussed, which is crucial for deep understanding rather than simply knowing the rules of interaction (Hadwin et al., 1996, Rajendran and Mitchell, 2007). For this reason, the implementation of social stories is often used in conjunction with role play and video modelling (Sansosti and Powell-Smith, 2008). Exposing the individual to interaction in this way may also increase the generalisation from the content of the story to other social situations, since the individual has a chance to see the rules applied in reality.

Furthermore, the direction of the story is determined at the outset and so does not allow the child to explore their own interests in the given social scenario. Having the pace of the intervention set by the adult may prevent the child deciding the pace and trajectory of the narrative. It is possible that this may decrease the motivation of the individual and therefore decrease the effectiveness of the intervention. However, the setting in which the story is introduced can go a long way to preventing this. For example, allowing the children to read the story themselves or out loud gives them a level of control that is likely to be appreciated.

2.3.2. Comic strip conversations

Another strategy devised by Carol Gray (1994a) is Comic Strip Conversations, which aim to assist individuals to develop their pragmatic social and interaction skills. Through the use of Comic Strip Conversations, the individual can explore and understand complex situations which they have previously had difficulty interpreting. The thoughts, feelings and emotions of others are identified and the consequences of different situations and actions can be explored and reinforced (Gray, 1994a).

Comic Strip Conversations are implemented as a means of structuring discussions between the child and the therapist, providing a visual representation of a situation (Bock et al., 2004). The child leads the discussion with the adult acting as the facilitator, with the child being encouraged to make their own decisions regarding the situation under consideration. Care should be taken to ensure that the adult reaches a balance between allowing the child to have control of the situation, whereby their own opinions and understanding are considered, along with the provision of accurate social information.

In Comic Strip Conversations, a conversation is represented by simple drawings and a library of symbols representing spoken word, thoughts and intentions, which provide consistency throughout the comic strips (Gray, 1994a). Using this library of symbols, basic conversations skills such as listening to others can be represented pictorially, with an emphasis on both the perspective of the child and the perspectives of others. As the individual becomes more advanced in their understanding of emotions and comic strip conversations, colour can be used to represent feelings and emotions (Gray, 1998).

Children with Autism Spectrum Conditions are frequently described as visual learners (Schreibman and Ingersoll, 2000, Grandin, 2002), with visual methods being identified as an effective means of representation over the auditory representation of information (Mesibov et al., 2005, Quill, 1995, Prizant, 1983, Scheuermann and Webber, 2002). Visual symbols

(e.g. cartooning) enhance the processing abilities of individuals with Autism Spectrum Conditions and enhance their understanding of the environment (Hagiwara and Myles, 1999, Kuttler et al., 1998). In particular, a cartoon style makes the specific environment in which the situation is taking place more abstract (Reidl et al., 2009), which may be useful in promoting generalisation, providing the child has sufficient understanding of the situation under consideration. It may also be argued that photorealistic images will promote generalisation since the children will have a deeper understanding of the situation with relation to themselves. Indeed the use of photographs in activity schedules has been particularly successful (e.g. (Krantz and McClannahan, 1998)).

The use of thought bubbles is typically to include text, as per traditional cartoons, with children as young as 3-4 years old having been shown to understand that thought bubbles represent what someone is thinking (Wellman et al., 1996). Further work has shown that the use of thought bubbles can lead to an increased ability to pass Theory of Mind tests (Wellman, 2002). For this reason, Comic Strip Conversations are often used to depict specific situations. It may address a previous incident that has caused difficulty or anxiety, consider a “live” conversation that is current (as a means of exploring new concepts and mapping them to a Comic Strip) or consider a forthcoming event where the child can prepare for a situation (Gray, 1998).

2.3.3. Computer-based interventions

Many of those with Autism Spectrum Conditions have a natural affinity with technology mostly due to the predictable nature of computers (Moore, 1998, Williams et al., 2002). In addition, it is possible to reduce many of the sensory inputs of the real world (Murray, 1997, Parsons et al., 2000), which may ordinarily result in sensory overload and associated anxiety or increased stress (Swettenham, 1996), thus confounding the information and making it

more difficult for learning (Gray and Garand, 1993). Furthermore, users can assume control of the pace of learning, while the computer will provide consistent, predictable and familiar responses (Powell, 1996), which can be repeated as required by the user (Moore, 1998, Panyan, 1984). The software is much more conductive to this repetition than a human companion, as software does not become impatient (Williams et al., 2002). This can create a comfortable, and to some extent relaxing, environment for children (Dix et al., 1998), particularly those with Autism Spectrum Conditions.

Due to these advantages, computers and other technological devices are considered to be motivating, safe and emotionally engaging by those with an Autism Spectrum Condition (Moore, 1998). Furthermore, Heimann et al (1995) proposed that students with Autism Spectrum Conditions enjoy learning more when taught by a computer than by a teacher; showing increased learning, motivation, attention and referential communication when compared with traditional personal instruction (Bernard-Opitz et al., 1990, Chen and Bernard-Opitz, 1993, Moore and Calvert, 2000, Bosseler and Massaro, 2003). Williams, Wright et al (2002) compared the effects of computer aided instruction to direct instruction by a teacher. It was found that participants with Autism Spectrum Conditions used more spontaneous gestures and verbal requests for help when using the computer aided instructions than when given direct instructions by the teacher.

Those with Autism Spectrum Conditions make use of external stimuli in order to manage the initiation, maintenance and termination of behaviours. Many different types of stimuli have been demonstrated to be effective. This includes gestural support, visual support (or representations), signing and spoken instructions (MacDuff et al., 2001). Computers can provide cost-effective methods of providing these types of prompts (Goldsmith, 2004), while retaining the advantages highlighted above.

The early use of computers as a therapeutic tool for children with Autism Spectrum Conditions was as a vehicle to implement social stories and comic strip conversations (Bernard-Opitz, 1990). For example, Sansosti and Powell-Smith (2008) and Panyan (1984), indicated success when using Power Point (Microsoft, 2010) to tell a Social Story. This involved three male participants, aged 6-10 years, being presented with individualised social stories to assist in initiating play activity and maintaining conversation. These stories complied with the recommendations made by Gray and Garand (1993). All participants showed improvements during the intervention phase and also a maintenance of behaviours during a follow up session conducted two weeks after the main body of the study was completed. In the study, authors noted that the use of the technology was a limitation since it required technical prowess. However, the use of computers and multimedia has continued, being promoted by Gray (2008) who suggests that computers can form the "Next Generation" of social story therapy. Furthermore, computers have been used as a vehicle to implement activity schedules (Rehfeldt et al., 2004, Hirano et al., 2010), which are important to retain structure and predictability for those with Autism Spectrum Conditions.

The current use of computers in research has been promising, with Computer Aided Instruction (CAI) being shown to increase the use of social skills in children with Autism Spectrum Conditions (Bernard-Opitz et al., 2001, Silver and Oakes, 2001, Swettenham, 1996, Rajendran et al., 2005), increase collaboration (Gal et al., 2009), increase play with siblings (Taylor et al., 1999), improve reading and communication skills (Heimann et al., 1995), increase vocabulary and grammar (Bosseler and Massaro, 2003, Moore and Calvert, 2000), improve joint attention (Whalen et al., 2006), decrease the occurrence of inappropriate behaviours (Chen and Bernard-Opitz, 1993, Whalen et al., 2006) and to promote relaxation and engagement (Keay-Bright, 2007a).

Despite the noted success of computers in research relating to social skills in children with Autism Spectrum Conditions, there is concern that this may encourage reliance on non-human interactions (Howlin, 1998) and result in an increased social withdrawal (Bernard-Opitz et al., 1990). Those with Autism Spectrum Conditions are prone to obsessions and so may become overly focussed on the technology being used, to the neglect of the social skills learning under consideration. The consideration of generalisation is of particular importance (Anderson et al., 2009) when using computer-aided interventions as the goal is to apply social skills in a real-life situation.

A number of products are commercially available for use in social communication therapy, the majority of which focus on the recognition of emotions from facial expressions. For example, "Faceland" (Do2Learn, 2009) comprises game-like activities which are designed to mimic SLT (Speech and Language Therapy) activities. Within an amusement park theme intended to engage and motivate students, videos are employed to accurately depict emotions, promoting clue acquisition through spaced repetitions. This is followed by comprehension questions which check for understanding of the materials. At this point, new examples are used in order to promote generalisation.

This example is typical of the majority of the work in this area, with the computer serving as a vehicle to provide information to individuals with Autism Spectrum Conditions, without the confounding social interactions experienced in the human-to-human communications.

Another series of products, developed by Animated Speech Corporation (2006), included a character named Timo. This animated tutor is friendly, interactive and patient. He provides timely feedback and reinforcement, with anecdotal evidence indicating that students enjoy interacting with him; some even claiming friendship with the character. The use of a character's face has been shown to increase learning in children with Autism Spectrum

Conditions (Massaro and Bosseler, 2006). However, the character uses synthetic speech, which is considered a possible limitation of the software (Whalen et al., 2009).

Some studies have claimed to demonstrate an increase in Theory of Mind abilities in participants using a variety of formats. Ozonoff and Miller (1995) explored social skills using computers in a group format, while Swettenham (1996) introduced simple computer-based programs to his participants. Hadwin et al (1996) went one step further in producing workbooks to accompany the computer-based learning program. These studies use standardised measures of Theory of Mind abilities to confirm improved abilities to pass Theory of Mind tests.

In recent years, there has been an expansion in the use of technology (other than computer based programs) to improve social interaction, e.g. (Dautenhahn and Werry, 2004, Robins et al., 2006). Robins et al (2006) investigated the use of robots in social interactions with individuals with Autism Spectrum Conditions. This study found that the participants with Autism Spectrum Conditions showed a preference to interact with a "technological" robot (without a human face) over interaction with a human-like robot. Further work by this research group (Robins et al., 2005) has found that the use of robots, in this case a small humanoid robot, can encourage children with Autism Spectrum Conditions to engage in social interaction behaviours such as eye gaze and imitation. This research therefore serves to reinforce the affinity that individuals with Autism Spectrum Conditions have with technology.

The use of virtual environments as a learning opportunity for those with Autism Spectrum Conditions also has potential (Cheng et al., 2005). In this situation, individuals with Autism Spectrum Conditions can effectively "role play" and experience the consequences of their actions in a safe and controlled environment. While this is useful in developing social skills, it can also be useful in teaching life skills (Neale, 1998), such as how to cross the road.

Tartaro and Cassell (2008) have cited the advantages of using a virtual human over actual humans. Virtual characters have a patience to interact with individuals with Autism Spectrum Conditions that is often difficult in human social partners, allowing computer users to repeat an action with predictable consequences.

There have been few studies in assessing the usefulness of virtual reality for those with Autism Spectrum Conditions. Strickland et al (1996) made use of a street scene with a fully immersive system, which included a headset. The two participants appeared to visually track cars on the street. This was considered a potential indicator of joint attention has led to preliminary support for the use of virtual reality environments. However, the fully immersive headset was not comfortable for participants. This is likely to be a recurring issue due to the sensory issues that are common within this group (Myles et al., 2004).

Other research has avoided the use of a fully immersive system, instead using desktop virtual environments. This can allow for the input of teachers or parents etc. who can work at the computer alongside the user (Neale, 1998) and thus encourage the generalisation of skills learned within the environment. Furthermore, Parsons et al (2004) have shown that, for the most part, children with Autism Spectrum Conditions interact with such environments in a similarly effective manner when compared to their typically developing peers.

Many examples of work conducted in this area count individuals with Asperger Syndrome or High Functioning Autism within the participant group (e.g. (Cobb, 2002, Rutten et al., 2003, Parsons et al., 2000)) rather than lower functioning participants with wider Autism Spectrum Conditions. The reasons behind this focus are unclear, but it is possible that the high functioning user groups may be more accessible to researchers since they are often schooled in mainstream classes. Furthermore, the preparation work required for the lower functioning group, such that the participants become accustomed to the presence of the

researchers, is much greater an undertaking. The limited research work that has been undertaken to include a wider participant group, such as Enyon (1997), has had positive results suggesting that the users achieved a meaningful interaction with the program. However, the participant group was not well reported as the users with Autism Spectrum Conditions were not specifically included in the final evaluation group, rather they were part of a larger group of individuals with disabilities or learning difficulties.

Regardless of the participant group, the use of virtual environments is particularly beneficial in improving procedural social behaviour, e.g. learning the sequences of actions within a task, such as finding an empty seat in a café (Cobb, 2002). This is different to the interactive social behaviours such as conversation and communications, which can be difficult to match to reality because of the varied nature of human interactions.

Another focus of the research conducted in relation to Virtual Environments has focussed on Collaborative Virtual Environments (CVEs), whereby the participants interact with others by controlling an avatar (Cheng et al., 2005, Rutten et al., 2003). However, this is an abstract form and so there is no direct "human" interaction (between the user and the characters in the environment) as all communications are conducted via an avatar. Despite this abstraction, there are a number of benefits. For example, the interactions within the CVE can be much more flexible and unlike the fixed response patterns frequently seen in single-user Virtual Environments (Parsons et al., 2000), such as those described above. For these reasons, the use of such virtual reality environments may promote generalisation, since there are many shared features between the virtual environment and the real-life environment.

2.3.4. Customisation, generalisation and maintenance

There are three main areas of consideration related to current interventions:

- **Customisation**: The adaptation of an intervention to match the needs of an individual (Whalen et al., 2009).
- **Generalisation**: The exhibition of a learned skill in a new situation, either geographically or socially (Anderson et al., 2009).
- **Maintenance**: The ability to continue performing a skill after instruction has stopped (Anderson et al., 2009).

Aside from the content of the intervention, these are areas where there are specific difficulties for those with Autism Spectrum Conditions (Silver and Oakes, 2001, Rogers, 2000, Gena et al., 1996, Sicile-Kira, 2003) in their learning and experiences of social interaction. These difficulties can often limit the effectiveness of an intervention and should be considered from the outset.

The creation of an intervention that can promote these aspects is the ultimate goal of research into treatments for Autism Spectrum Conditions. Despite this, it is uncommon for research studies to directly measure maintenance and generalisation, most likely because there is no accepted standard of measurement and the research methodologies used can vary dramatically from one study to another. The methodological challenge is mainly due to the heterogeneity of the participant group. In addition, many experimental studies have only a limited number of participants; the range commonly seen is between one and four in a case study format, although there are some exceptions, e.g. (Baron-Cohen and Way, 1997, Baron-Cohen et al., 1985). The interventions used can vary greatly in both type and content between participants and studies. In summary, the studies with larger groups of participants used age-matched controls to make inferences about a larger participant group, such as “adults with Asperger Syndrome”, using primarily quantitative data and compared to

typically developing (or similar) control groups, whereas the studies with fewer participants focussed on very specific attributes, skills and difficulties of each individual participant using qualitative data.

Customisation

Since individuals with Autism Spectrum Conditions typically have a narrow field of interests commonly known as 'monotropism' (Murray et al., 2005), the creation of an engaging intervention can be difficult and so there is often customisation of the intervention provided in order to accommodate the specific desires of an individual child. Providing opportunities for individuals to share these areas of interest with others can increase their effective communication, since they are familiar with the area of interest, thus reducing the social anxiety that may occur when dealing with a new topic.

Individualisation is considered to be crucial to the success of an intervention (Higgins and Boone, 1996) and is noted to be a key component in increasing any subsequent generalisation of skills (Whalen et al., 2009). Gray (1995) highlighted the importance of adapting the story to the child's age, interest and comprehension levels. Additionally, an individual may have specific social needs that are to be addressed and these should be reflected in the intervention. For example, Bledsoe et al (2003) focussed on addressing mealtime behaviours including appropriate table manners, an area of particular difficulty for the participant.

The process of customisation can be time consuming, but is necessary to ensure that the chances of success are increased (Gray, 1995). If the customisation of an intervention was more efficient in terms of reduced workload and increased speed of creation, it is likely that the increase in production of interventions will result in an increase in effectiveness. This could be achieved through a use of intelligent technology.

Generalisation

Two types of generalisation are considered in research within the realm of Autism Spectrum Conditions (Putnam and Chong, 2008). Firstly, this is the practical aspect of whether a skill learned in one situation can be applied to another, different situation. The second aspect is the generalisation of research results with one participant to a wider group. This is particularly difficult to imply due to the heterogeneity seen in Autism Spectrum Conditions, as participants present with many unique and eclectic difficulties in social skills.

The generalisation of skills learned through use of the intervention is of importance, since skills are rarely useful if they can only be applied to one context or situation (Anderson et al., 2009). For example, if a child with an Autism Spectrum Condition is taught to greet a sibling at home (e.g. "hi") then this can be generalised to greeting other family members at home, or greeting the sibling or peers in a school environment.

Generalisation is difficult in Autism Spectrum Conditions due, at least in part, to stimulus over-selectivity, and as a consequence, it is beneficial to teach similar skills as applied to different situations (Koegel et al., 1995), through offering multiple exemplars of the skill in context (Stokes and Baer, 1977). If an intervention can be designed in such a way as to promote this transfer of learning then it will be more effective, possibly reducing the intensity of interventions required to provide skills across a range of situations. Tan (2000) noted that the generalisation of problem solving skills from a computer to reality depends on similarities between the simulated problem and the problem in reality. In this study, children with Autism Spectrum Conditions were able to reach the fruits on a tree on the computer. This was generalised to reaching a balloon in reality, but not to other situations that had not been explored using the computer. In this case, bargaining skills were used as an example.

It has been proposed in the literature that the focus of interventions should be the generalisation of the skills (Rao et al., 2008) and that generalisation should be considered in

the design of an intervention from its conception (Anderson et al., 2009). This should include working on developing the skills the individual is learning in naturalistic and functional ways (Whalen et al., 2009), including activities within the classroom or a focus on these skills in the home.

In some studies, no generalisation in shown, even to closely related tasks in a different medium (e.g. (Swettenham, 1996)). In this study, participants were taught about false-belief in order to progress their Theory of Mind abilities. After the teaching sessions, participants were able to pass a computerised false-belief task, using the same scenario as the teaching tools, but were unable to generalise the skills learned to a different scenario.

However, some studies have successfully shown generalisation (e.g. (Delano, 2006)). Social skills were targeted through the use of Social Stories and generalisation was investigated with both a novel peer and a novel situation (the classroom). In both situations this was successful, continuing during the maintenance phase, and may be attributed to the unique use of a novel peer. This novel peer was a classmate who had not previously worked with the participant, and generalisation in this case is a clear indicator of real-life applicability since the novel peer is likely to be encountered in reality. Other social stories interventions show generalisation including Ozdemir (2008) and Scattone (2008), although these included the use of multimedia and video modelling, which may have increased the likelihood of success. Golan (2006) also used interactive multimedia to generalise the recognition of emotions to closely (but not distantly) related tasks. However, the participants in this study were diagnosed as having Asperger Syndrome, rather than a wider Autism Spectrum Condition. Silver and Oakes (2001) showed generalisation of emotion recognition using both a computer-based intervention and a paper-based intervention. This computer-based intervention was very similar to the paper-based intervention, a fact that undoubtedly assisted the process of generalisation. However, like previous studies, many of the

participants were considered to be high functioning, although they did show variable levels of developmental delay.

Structured observations are often used (Scattone, 2008) to determine the extent of generalisation compared to the experimental situation. Interviews with parents (Rowe, 1999) are also used, although these are often less reliable than directly observed behaviours (Bryman, 2008). This is even more problematic when the small numbers involved are considered, meaning that results cannot be generalised to the wider population and are specific to the individuals within the study. The methods of measuring generalisation vary between studies. Most (e.g. (Silver and Oakes, 2001)) have considered related tasks which are similar to those performed on the computer. Successful completion of these tasks show generalisation from the computer environment to reality, but it is possible that the child learned to complete the task without fully comprehending the social implications (Whalen et al., 2009). Whalen proposes that in order to overcome this difficulty, researchers should focus on measuring generalisation through probes or 'engineered situations' in un-structured situations within the child's naturalistic environment.

Maintenance

The maintenance of skills acquired through the implementation of the intervention is when the child continues to display these skills after the intervention has ended (Tse et al., 2007). This is crucial both for the acquisition of new skills and the opportunity to build on skills already learned (Anderson et al., 2009). The intervention should be reviewed on a regular basis, ensuring the current intervention is most closely fitted to the needs of the individual.

In order to measure maintenance, the final evaluation test is typically repeated some time after completion of the study. Depending on the specific study, this may be observations, video recordings or testing procedures specific to the research context. Considering studies

reported in the literature, the typical time period lapsed before evaluating the maintenance of skills was two weeks (e.g. (Rao et al., 2008, Crozier and Tincani, 2007)). Both studies have shown successful maintenance, with other studies showing maintained improvements in behaviours at 5 weeks (Kuoch and Mirenda, 2003) and also some improvement above the recorded baseline up to 10 months later (Chan and O'Reilly, 2008).

However, notwithstanding the positive move towards maintenance being reported in the literature, a survey of teachers in special education (Reynhout and Carter, 2009) found that while 93% of respondents consider their social story interventions effective, they report mixed results concerning maintenance of skills, with 40% of respondents unsure if their stories result in well maintained skills.

Chapter 3. **Participatory research**

This chapter reviews the area of participatory research, focussing on the use of this methodology within the literature. In particular the use of participatory research methodologies with children and those with Autism Spectrum Conditions is discussed.

Participatory research is an umbrella term for a variety of methodological approaches (Kindon et al., 2007a) that involve researchers and participants working together to examine a problematic situation and action changes for the better (Wadsworth, 1998). These methodologies are focussed on "knowledge for action" (Scott and Shore, 1979), with the benefits of the research accruing directly to the communities involved. Various types of participatory research have been conducted since the mid-1940s (Kindon et al., 2007b). Participatory research began as a movement for social justice (Green et al., 1994), being explicitly oriented towards social transformation (McTaggart, 1997) and has previously gained prominence in the fields of health (Macauley et al., 1997, Travers, 1997), and social inclusion (Plough and Olafson, 1994), along with the political arenas of liberalism (Brown and Tandon, 1983) and feminism (Joyappa and Miartin, 1996). More recently, the term "Action Research" has come to fruition; the *"situational intervening, diagnosing and solving a problem in a specific real-world context"* (Grey and Malins, 2004). This is congruent with participatory research, designed to promote the acquisition of practical knowledge (Reason and Bradbury, 2001) with an intention to impact on practice (Cohen et al., 2000), as opposed to generalising the knowledge to form and inform theory.

Participatory research involves the user group and researchers in a collaborative process for generating knowledge. Since *"no single technique can accomplish everything"* (Goodwin, 2009), a variety of methods are typically used. Common methods include focus groups,

interviews, participant observation, task analysis, storytelling (Kindon et al., 2007b), brainstorming, diagramming and ranking lists (Pain and Francis, 2003). Work is conducted in groups with the participants and researcher working together, promoting information sharing between the two groups in order to work towards an effective solution or result for both parties. The focus is on iteration (Fisher and Ball, 2003), with the researcher and participants shifting between phases of action and reflection. The researcher should relinquish control (Sense, 2006) and facilitate rather than direct the process (Wadsworth, 1998).

Using a participatory research methodology, researchers can tailor research tools for specific participants (Pain and Francis, 2003). The participants themselves are experts in the area being addressed, resulting in a more meaningful problem definition and solution than the researcher could develop alone. In addition, there are numerous opportunities for empowerment (Pant, 2007). For example, the ability of participants to contribute in social relationships can increase due to the experiences of group work and research, with groups of individuals working together to achieve a more extensive impact.

Within the realm of participatory research, the use of User-Centred Design methodologies is paramount in order to ensure a continual integration of a participant perspective in the research. This user involvement is essential at all stages of the research, but is particularly critical during the design of the human-computer interface (Waller et al., 2005a). This stage occurs after the definition of the problem area and begins as the researcher and participant work towards a solution.

User-Centred Design within software engineering is defined by the International Standards Organisation as *"an approach to interactive systems development that aims to make systems usable and useful by focussing on the users, their needs and requirements, and by applying*

human factors/ergonomics, and usability knowledge and techniques" (2010). Comprising the involvement of stakeholders at all stages of the design process (Smith, 1997), User-Centred Design makes use of iterative prototyping to refine the design of technology and a continuous iterative evaluation of this design and the resultant technology implementation (Preece et al., 2007). This includes the early and continual involvement of users (Gould and Lewis, 1983), beginning with the gathering of requirements. Where the concept of User-Centred Design is not fully embraced by those who develop software and technology systems, the resulting technology can be unacceptable, dangerous or simply not useful to the end users (Preece et al., 1994, Lee, 1992).

Selecting an appropriate methodology and ensuring a consistent application of User-Centred Design can be difficult, but the benefits of this approach are frequently acknowledged in the literature (e.g. (Muller and Haslwanter, 1997, Schuler and Namioka, 1993)). To such ends, the International Standards document, ISO 9241-210 (ISO, 2010) aims to provide a framework for applying User-Centred Design principles, which are intended to supplement existing lifecycle models in order to achieve the creation of usable interactive systems, for both the end user and other stakeholders in the development. The use of the ISO standard is widely considered the best way to improve the usability of software, guidelines and design frameworks (Vredenburg et al., 2002).

While it is not apparent what the best techniques in user participation are (Karat, 1997), there is an understanding that early user involvement is crucial (Kujala, 2003) and so the practice of User Centred Design has persistently evolved. The involvement of the user in the design of software can vary immensely both within and between projects, although traditional 'User Centred Design' typically positions users as testers and evaluators of the software (Rubenstein and Hersh, 1984, Druin, 1998). This involvement can be considered

along a spectrum (see figure 2) (Olsson, 2004), from the designer thinking about the user, to the user being the designer. Druin (2002) proposed a similar spectrum with the user being considered a user, a tester, an informant or a design partner throughout the technology development. Through this user participation, the needs and preferences of end user groups are considered from an early stage, in order that the developers can fully comprehend what the end users really need and want (Preece et al., 2007), with the aim being to create a more meaningful integration of design and functionality (Preece et al., 2002).

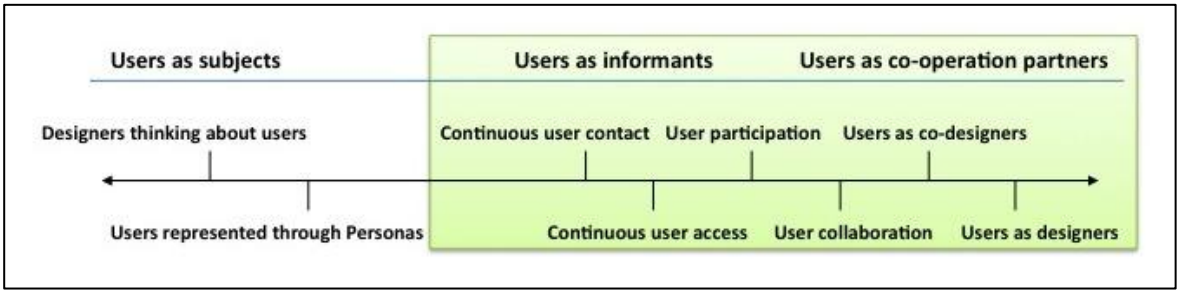


Figure 2: Spectrum of user involvement (Olsson 2004)

In order to engage in a fully integrative participatory design process, the researcher must adopt a lesser spectrum than that pertaining to User Centred Design processes in the literature (e.g. (Olsson, 2004)). In figure 2, the shaded area represents the levels of participant and researcher interaction considered as participatory design, whereby there are opportunities to engage participants as active contributors (Chambers, 1992). The delineator of participatory design is the active involvement of users, with an absence of the "users as subjects" category. The users should be actively involved in the research process most often as co-designers with the research team. The techniques and methodologies applied depend on the level of involvement of the user, as well as the users' individual capabilities. Some

participant groups are more suited to being informants of the design and research, rather than taking responsibilities for design. For example, participants with developmental disabilities (Porayska-Pomsta et al., 2011) may not fully understand the research or design process but can contribute opinions and test prototypes or ideas. The crucial factor is that participants are working together with the researchers (Wadsworth, 1998) to create solutions to defined problems. This collaboration will typically lead to a multi-disciplinary approach to the design and development of the technology products, thus ensuring that the resulting technology is usable for the end-users (Preece et al., 2007).

3.1 Participatory research and design with children

An early and continual focus on users has been highlighted (Gould and Lewis, 1983) and is central to the International Standard Organisation document 9241-210 (2010). The emphasis is on understanding the users in order to create a system that is both functional and usable. Thomas and O'Kane (1998) argue that when research involves children, the reliability and validity of the research can be augmented by involving children directly in the research conducted. It has also been noted by Read et al (2010) that in order to create a good design of technology, it is *"necessary to enter into a child's world to ensure that the resulting products provide a good experience for the children"*. This suggests that the experience a child has in interacting with technology is dependent on the validity of the designs and that these designs are best created and evaluated with the involvement of children.

However, until recently, child users (particularly those with disabilities) were infrequently involved in the design and testing of computer systems (Druin, 2002). For example, using Conlon and Pain's Persistent Collaboration Model (1996), educational technologies were developed in collaboration with teachers. Since the end-users (pupils) could not be directly

consulted, teachers and researchers observed the children using the educational technologies and determined the impact these technologies had on learning using their own expert knowledge. At the time of publication, even this use of proxy users as a means of user contribution was limited in the literature. Future work by the authors has furthered this involvement by ensuring that the end users (pupils) contributed to the formative evaluation.

Children with disabilities are often considered via proxy users, such as parents or teachers (e.g. (Waller et al., 2005b, Plaisant et al., 2000)). This is often not the first choice situation for the researchers. However, in itself, this can be useful as it allows for experts to provide opinions and insights into the design and development. Notwithstanding this expert involvement, there should be complementary interactions with the end users (Smith, 1997). In some cases, the expert or proxy user may think that they know what the child wants when in actual fact they do not.

Where children are actively involved in Participatory Design, a popular involvement is as a "design informant" (Scaife et al., 1997), whereby the designers build a prototype, which is assessed by the child end-users. The "co-operative inquiry" methodology elicits the needs and desires of the users (Druin, 1999), which can assist in the evaluation of the technology or software. There are a number of recent examples of children being meaningfully involved in the design and development of technologies and software. Children aged 7-10 years of age, have an *"emerging capacity for reflection and abstraction"* (Read et al., 2002) coupled with a *"lack of preconceptions about the design domain"*. This means that children of this age are ideal for involvement in participatory design work.

For example, Goolnik, Robertson et al (2006) used the CARSS framework (Good and Robertson, 2006) to structure a user-centred approach which allowed for the development of the Adventure Author Tool; a tool to facilitate the creation of interactive narratives within

virtual environment. This involved the creation of a series of prototypes, which were evaluated by six 10-year old children. These prototypes evolved from paper-based low-fidelity prototypes to computer implementations of high-fidelity prototypes. The study concluded that the use of child end-users in the evaluation was useful and that this was instrumental in informing the future design of the Adventure Author Tool. In this research, the child users were not involved as equal design partners as this group was unfamiliar with the complex domain of interactive narratives. This group reinforces that described by Conlon and Pain (1996), indicating that it is unrealistic that the children could be equal contributors to the design process, as their lack of domain knowledge means that they are unlikely to propose innovative strategies or designs for the software.

In other domains, the child users have been involved in the design stage of the development, such as work by Wood and Romero (2010) which involved stakeholders, including adolescents aged 16-17 years and teachers, in iterative design and prototyping to create an application to generate real-time movement graphs. The application was to be used by the teachers to illustrate concepts of movement graphs in real-time using GPS technology to mathematics students. Wizard of Oz methodologies were used for evaluations. The participant groups were not well defined within the paper, but the methodologies and user centred, iterative nature of the prototyping were clearly defined and "useful" in their contribution to the development and validation of the design.

Other work in participatory design involving children includes Read et al (2010) who used obstructed theatre to gather requirements from children, Xu et al (2009) who used drawings to evaluate interfaces such as the Nintendo Wii, Horton and Read (2008) who used questionnaires to determine children's' understanding of technology and Mazzone et al (2010) who developed participatory design activities such as drawings, craft activities and

worksheets, for children to design a music device. This work has been conducted by members of the Child Computer Interaction Group at the University of Central Lancashire (The-ChiCI-Group, 2011), the only research group in the UK to focus solely on Child Computer Interactions, giving "special consideration" to the usability of technology for children. Research by this group has given rise to a number of recommendations with regard to the design and development of Participatory Research activities for children. These include the importance of using multiple modalities for children to express their ideas and the involvement of a teacher before and during sessions to ensure the suitability of tasks for children (Mazzone et al., 2010). The importance of an engaging medium, which is enjoyable to children is also noted (Read, 2008), in order to ensure that children can evaluate software and technologies in meaningful ways.

3.2 Design and autism spectrum conditions

The implementation of User-Centred Design methodologies is of particular importance when working with and designing for audiences with special needs (Fischer et al., 2002). Since it can be difficult to engage children with Autism Spectrum Conditions outwith their special area of interest (Gagnon, 2001), children with Autism Spectrum Conditions are often marginalised in the design process (Porayska-Pomsta et al., 2011). Therefore it is of paramount importance that this user group is consulted in order to create software that will engage the users. Standard techniques that foster an equal design partnership between user and researcher is too stressful for those with Autism Spectrum Conditions, particularly children, given their social difficulties. For this reason, techniques that facilitate feedback must be tailored to meet the needs of the user group involved in participatory design, such

that the resultant feedback is not misinterpreted and is understood in a meaningful way (Keay-Bright, 2007b).

Despite these recommendations, and evidence of success, children with disabilities are infrequently involved in the design of software, instead having a greater involvement in the testing of computer systems (Druin, 1998, Pares et al., 2005). This limited involvement in participatory design limits the impact of the user group on the outcome of the design (Frauenberger et al., 2011). Children can become overburdened with creative responsibility (Jones et al., 2003), and this can be amplified in participants with Autism Spectrum Conditions (Porayska-Pomsta et al., 2011). Furthermore, it can be difficult for researchers to access the target group and set up participatory design groups due to the low numbers of participants available with the desired user profile. Furthermore, children with Autism Spectrum Conditions often have very structured timetables, meaning that the access to this user group can be infrequent and time-restricted (Frauenberger et al., 2011). Guha et al (2008) have considered the lack of involvement of children with autism (and other special needs) in participatory design, outlining an inclusive model of Co-operative Inquiry based on the original work by Druin (1999), which focuses on the level of involvement of the children and the additional support required, such as physical support, and the provision of human support such as a trained aide to assist the child.

Many studies have attempted to justify the lack of involvement of children with Autism Spectrum Conditions in their research. For example, Woodcock et al (Woodcock et al., n.d., Woodcock and Georgiou, 2007) claim to incorporate a user-centred approach in the creation of a polysensory environment that can be tailored to meet the needs of individual children with Autism Spectrum Conditions. However the researchers followed a “design *for* users” approach, noting difficulties in gathering requirements from young children; children with

Autism Spectrum Conditions not being able to communicate with the researchers and that the available small set of children was not a representative sample. This was a common difficulty in many studies. However, attempts were made to understand end users through the involvement of proxy users. In this case parents and teachers were involved in observations, surveys and semi-structured interviews. Work by Marti and Guisti (2010) also involved proxy users in the design of robots, despite the authors noting that end users (children with Autism Spectrum Conditions) were involved as "active agents" within the design process. Disappointingly, this involvement was only as testers of the technology robots, with the design being created by the proxy users. However, the fact that the proxy users within this research developed the evaluation strategy as expert advisors was noteworthy, as this ensures that the evaluation scenarios were suitable for the ability of individual participants (Robins et al., 2008).

As a whole, these examples highlight clear difficulties in involving children with Autism Spectrum Conditions in participatory research, as summarised by Millen (2010b) within the categories given below:

- **Limited language and communication skills:** this can make it difficult for children with Autism Spectrum Conditions to articulate and evaluate design ideas and for researchers to elicit opinions on designs.
- **Poor imaginative skills:** the use of low fidelity prototyping can require the use of imagination to envisage the final product, so a lack of imaginative skills can make this concept difficult.
- **Rigidity of thought process:** this can have implications for arranging and structuring sessions. Where routines are disrupted children with Autism Spectrum Conditions may exhibit anxiety and be less engaged in the design activities.

- **Theory of Mind impairment:** it can be difficult for children with Autism Spectrum Conditions to offer opinions based on personas or their knowledge of peers. It may also be difficult for them to generalise their own characteristics or opinions within a user group.
- **Learning difficulties:** Learning difficulties and disabilities are often concurrent with Autism Spectrum Conditions. Reduced intellectual abilities may mean that the child is unable to fully understand the concepts required during involvement in the design process.

Considering these difficulties and those of other special needs groups, it is clear from the literature that current methodologies may not be useful as they are often incompatible with the specific social difficulties encountered in Autism Spectrum Conditions. For example, the think-aloud method (Lewis and Rieman, 1993) is often used in the development and evaluation of software, but requires the articulation of thoughts (Fonteyn et al., 1993); an ability which is often delayed or absent in Autism Spectrum Conditions (Hill et al., 2004).

There are, however, limited examples available in the literature of these difficulties being successfully addressed in order to actively involve children with Autism Spectrum Conditions in the design process, as opposed to depending on proxy users. These are summarised in table 3 and discussed below. Given the limited number of examples that indicate low-functioning Autism Spectrum Conditions, it is clear that individuals with the most severe social and communicative dysfunctions are disenfranchised by power shifting to more highly functioning individuals with Autism Spectrum Conditions (Keay-Bright, 2007b).

Table 3: Involvement of children with Autism Spectrum Conditions

Author(s)	**Research purpose**	**User group**	**Involvement of ASC users**	**Participatory Design activities**
(Millen et al., 2010b, Millen et al., 2011)	Collaborative Virtual Environment for developing social skills	Autism Spectrum Disorder	Design informant, evaluator	Worksheets, group discussions
(Howson et al., 2004)	Communication Aid	Children with Autism Spectrum Disorder	Evaluator	Evaluation of prototyping
(Whaley et al., 2004)	Electronic schedule	Autism Spectrum Disorder	Evaluator	(Not specified)
(Keay-Bright, 2007b)	ReactiveColours	Children with Autism Spectrum Disorders (4-7 yrs)	Design informant, evaluator	Storyboarding, observations, prototyping workshops, evaluation of prototypes
(Pares et al., 2005)	Interactive Multisensory Environment	Autism Spectrum Disorders (low-functioning) (6-12 yrs)	Design informant, evaluator	(Not specified)
(van Rijn and Stappers, 2008)	LinkX	Autism Spectrum Disorders	Design informant, evaluator, co-researcher	Observation, interviews (others not specified)
(Frauenberger et al., 2010, Frauenberger et al., 2011)	Echoes	Asperger Syndrome	Design informant	Design workshops, observations, group discussions
(Woodcock and Georgiou, 2007)	Creation of polysensory environment	Young children with Autism Spectrum Disorders	Evaluator	Observation
(Marti and Giusti, 2010)	Design of robots	Autism Spectrum Disorders	Evaluator	Observation

One example of research involving those with Autism Spectrum Conditions is that conducted by Millen et al (Millen et al., 2010a, Millen et al., 2011), where user centred design methodologies are employed to develop a Collaborative Virtual Environment to support the development of social skills in Autism Spectrum Conditions. Both typically developing children and those with Autism Spectrum Conditions were involved in the design process. Although the children with Autism Spectrum Conditions are not well described within the research it can be deduced that this group are reasonably highly functioning since they were literate and placed in a mainstream secondary school. The number of children involved was small (n=3).

Design activities included worksheets to determine the child's understanding of friendships and drawings of potential blue-sky designs. These were successfully adapted for use with those participants with Autism Spectrum Conditions. For example, text-based worksheets were presented as mind map representations to take account of the fact that children with Autism Spectrum Conditions are typically visual learners (Grandin, 2002). In addition, the activity requiring the child to draw their sample designs was adapted to include an outline of a computer screen. This gives the task context and scope, thus avoiding the presentation of blank paper, which can be distressing and daunting for those with Autism Spectrum Conditions (Worth, 2005). Finally, a visual timetable is included. This was referred to after each activity, providing structure for the sessions (Mesibov et al., 2005, Marcus, 2010). This helped to reduce participants' anxiety since the participant knows what to expect, what is expected of them and can further reinforce the instruction relayed by the researcher.

It has also been proposed by Millen et al (2011) that participatory research activities should avoid open-ended questions, which may lead to frustrations and anxieties, such as "What did you like about the game?". Participants should be encouraged and reassured that there is no

correct answer. The task should also be constrained and focussed in order to encourage engagement from the participants. In addition, this research indicated possible issues in the use of personas in research by children with Autism Spectrum Conditions, with mixed results. The participants found it difficult to imagine the persona in reality. The difficulties with this abstraction are likely related to difficulties with Theory of Mind abilities and poor imagination skills.

Throughout the successful involvement of children with Autism Spectrum Conditions in participatory research, the principle of empowerment is prominent, but *"the balance between empowering children and over-burdening them with responsibility is a delicate one to manage"* (Frauenberger et al., 2011). Children, particularly those with disabilities, show enhanced enjoyment when they are involved in the creation of technology to help both themselves and others. This gives rise to an increased confidence, both within the research and in the wider environment (Waller et al., 2009). Additionally, children with Autism Spectrum Conditions are likely to benefit from the provision of new activities that extend current learning or therapy opportunities as the children gain experience in, and support their development of, social interaction and communication. This leads to an increase in knowledge, skills and abilities that can enable them to develop their own social learning.

An example of a project that has utilised a participatory focus towards the social inclusion and empowerment of children with Autism Spectrum Conditions is the Echoes project (Echoes, 2009). The inclusion of users with Autism Spectrum Conditions along with their typically developing peers has led to a positive research environment where the children are involved in numerous design activities, which are interpreted by the researchers in a meaningful way (Frauenberger et al., 2010). These activities resulted in the creation of 26 design concepts that were implemented in a Technology Enhanced Learning (TEL)

environment. Activities included the “Projecting Contexts” activities, in which the children were introduced to the garden location (where the Echoes project was set) and the character Paul who was found within the garden. Initially, worksheets allowed the children to indicate imaginary behaviours of objects within the garden. Tangible art-based activities then gave the children a focus of learning (Papert and Harel, 1991) and created narratives for within the Echoes environment. Finally a Wizard of Oz interaction with the character Paul, allowed the children to interact with their tangible objects in the physical world and connect these to the digital environment of Echoes. Of importance in this research, an emphasis was placed on recognising the involvement of the child participants in the research. The participants were given certificates to highlight and reward their participation. In addition, the Echoes project provided a video summary of the children’s involvement and played this at a special school assembly.

Another research project which has involved lower functioning children with Autism Spectrum Conditions in meaningful design activities during critical stages of development is the Reactive Colours Project (Keay-Bright, 2007b). In this project, software was created to provide opportunities for children with Autism Spectrum Conditions to engage in exploratory play. The software, ReacTickles, has exploited the desire for repetitive actions seen in Autism Spectrum Conditions in order to allow the users opportunities to control their own environment through these actions. The iterative development lifecycle employed allowed the involvement of numerous stakeholders including children, teaching staff, graphic designers and experts in assistive technologies in the design and documentation of the system. Involvement of children with Autism Spectrum Conditions included observations, interaction with prototypes and involvement in the summative evaluation phase during play. Of importance in this research, direct knowledge elicitation

methodologies were avoided. Instead, the researcher attempted to *"gain understanding through (the actions of the children)"*, including their body activities, expression and language.

As a whole, the research considered above shows an increasing focus on the involvement of children with Autism Spectrum Conditions in participatory design, albeit at differing levels of participation.

Chapter 4. **Summary of methodology**

The research philosophy of this thesis is one of inclusion, with multiple stakeholders, including children, being involved early and throughout the research (Gould and Lewis, 1983). The undertaking of such involvement can be time-consuming, restrictive and expensive, with a lack of readily available strategies for effective integration with existing methodologies. However, the benefits far outweigh these disadvantages. Through *"entering into a child's world"* (Read et al., 2010), the inclusive research philosophy and engaging methods have ensured that the end-users are represented in meaningful ways alongside other stakeholders.

The involvement of children with Autism Spectrum Conditions has added a further layer of difficulty, since this user group can be difficult to engage, motivate and focus on the task. However, these issues have been overcome through exploratory methodologies and ensuring a cross-representation of users at all stages.

This chapter outlines the structure of the research undertaken and describes the participants that have contributed to the research and design of the sharing system.

4.1 Structure of the research

The International Standards document, ISO 9241-210 (ISO, 2010), shown in Figure 3, was used as a framework for applying User-Centred Design principles throughout this research by involving stakeholders at all stages of the design process (Smith, 1997). Based both on the researcher's experience and the literature reviews of Chapters Two and Three, user involvement was considered to be crucial to the success of the research and was sought from the outset.

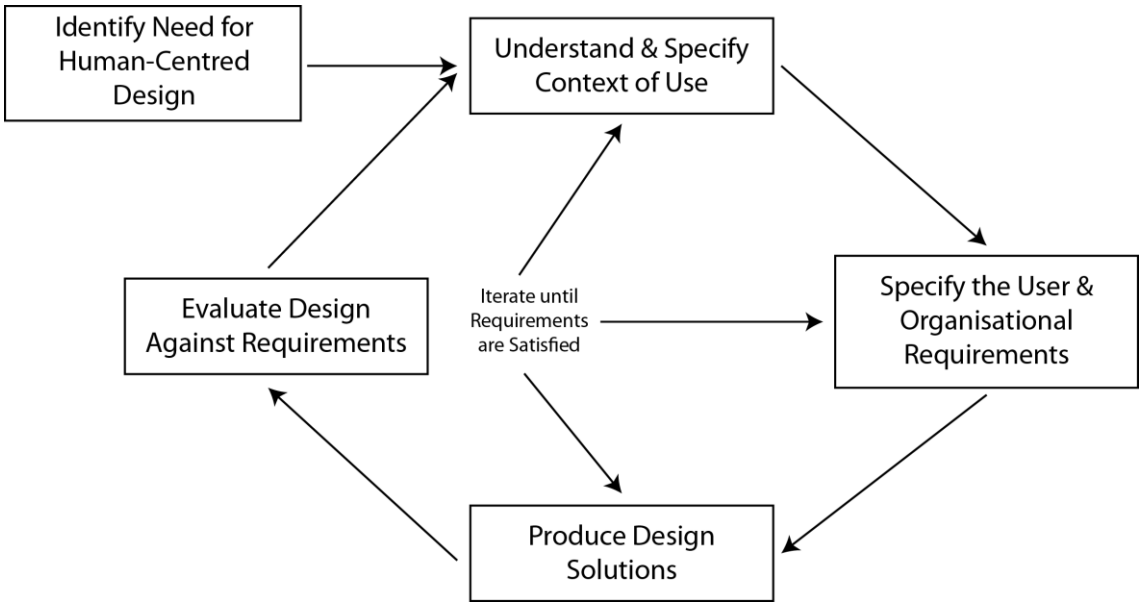


Figure 3: ISO 9241-210

Initially, a literature review was conducted of the development of social skills and participatory research, with a focus on the involvement of individuals with Autism Spectrum Conditions. Interviews and observations were then conducted as exploratory studies in order to understand and specify the context of use of the system. These studies were instrumental in defining the problem area and forming research questions.

Undertaking a number of studies described within the 'Studies to Inform Design' chapter led to a specification of requirements for both the user and the school environment. These studies included interviews, discussion groups and previous experience of software evaluations for children with Autism Spectrum Conditions.

A design prototype was then implemented by the research, before being refined during the formative evaluation phase which utilised methodologies such as interviews, a focus group and user observations. Modification of the prototype was iterative throughout the period of formative evaluation and was concluded when the prototype fulfilled the specified requirements.

The fully developed prototype was then implemented using Adobe Flex SDK 3.5 and Actionscript 5.0. Summative evaluation was undertaken using a mixed-method experimental protocol. The gathered data was subsequently analysed with respect to the research questions developed as a result of the initial exploratory studies.

4.2 Participant involvement

Participant involvement is essential in achieving the successful development of a user-based system (Kujala, 2003) and was central to the success of this research. Participants were involved throughout and contributed widely to the structuring of the research space, the development of research questions, the design of the system and its continual evaluation in the school environment. In order to avoid repetition, all participants are described in this section. Each section of work is highlighted and the participants noted. Full participant descriptions are found in alphabetical order in Section 4.3. The age of participants reported is the age at which they participated in the research studies. For the purposes of privacy, pseudonyms are used for participants. Where participants have directly contributed to the research they are subsequently mentioned by pseudonym in the relevant chapter.

A total of 31 adults and 70 children (34 typically developing, 36 with Autism Spectrum Conditions) contributed to the research. These individuals were involved at different stages of the research. Some of these participants made individual contributions to the research, while others participated as part of a group, such as an advisory board or class of children. Participants who contributed significantly across the research process are noted using a pseudonym below. Table 4 shows the participant recruitment from different environments.

Table 4: Summary of participants across all settings

		Adults		Children		
Setting	Type	No of Adults	Occupation	No of Children (ASC)	No of children (TD)	Age Range (years)
A	Mainstream primary school with additional needs unit	3	2 Teachers, 1 Speech and Language Therapist	16		5-8
B	Special Needs school	5	2 Teachers, 3 Support for Learning Assistants	7		8-13
C	Speech and Language Unit	1	Speech and Language Therapist	8		5-8
D	School holiday club			2	3	4 - 8
E	Mainstream primary school	1	Teacher		31	7-8
F	Mainstream primary school with additional needs unit			3		6-7
G	Mainstream primary school	3	Teachers			
H	Usability Consultancy	2				
I	Advisory board	16				
		31		**36**	**34**	

Adults

Of the 31 adults who participated, 16 participated as an advisory board to the Echoes project and 15 were recruited directly by the researcher. Further information about these participants is supplied in table 5 and in the written description in Section 4.3. Their overall involvement in the research is summarised in table 6.

Table 5: Summary of adult participants

Name	Setting	Occupation	Current Specialty	Years Experience
Sarah	A, C	Speech and Language Therapist	Recently retired	40
Rosalyn	A, C	Speech and Language Therapist	Autism in children	2
Yasmin	B	Teacher	Special Needs / Autism	15
Sally	A	Teacher	Mainstream with Additional Needs	35
Samantha	B	Support for Learning Assistant	Special Needs	15
Amanda	A	Teacher	Mainstream with Additional Needs	30
Matthew	E	Teacher	Mainstream	10
Damien	H	Usability Professional	Web Development	5
Simon	H	Usability Professional	Entertainment Software	5
Natalie	G	Depute Head Teacher	Mainstream with Additional Needs	8
Margaret	G	Teacher	Mainstream	8
Amy	G	Teacher	Mainstream with Additional Needs	15
Ruby	B	Depute Head Teacher	Special Needs / Autism	10
Heather	B	Support for Learning Assistant	Special Needs	>25
Dawn	B	Support for Learning Assistant	Special Needs	7

Table 6: Involvement of adult participants (pseudonyms used)

Name	Exploratory Studies	Studies to Inform Design	Formative Evaluation	Summative Evaluation
Sarah	✓	✓		
Rosalyn	✓	✓		
Yasmin	✓	✓	✓	
Sally	✓	✓		
Samantha		✓	✓	
Amanda		✓		
Matthew		✓		
Damien			✓	
Simon			✓	
Natalie			✓	✓
Margaret			✓	✓
Amy			✓	
Ruby			✓	
Heather			✓	
Dawn			✓	

Children

Of the 70 child participants, 34 were typically developing and 36 were diagnosed as having an Autism Spectrum Condition. The researcher recruited these children to participate in the research from across a variety of settings. Further information about those participants with an Autism Spectrum Condition diagnosis who participated individually in the research is supplied in table 7. Written descriptions of all child participants can be found in Section 4.3. Their overall involvement in the research is summarised in table 8.

Table 7: Summary details for participants with a diagnosis of Autism Spectrum Condition

				At start of research		
Name	Sex	Diagnosis	Communication Abilities	Receptive Vocabulary Age (years)	SCQ Score	Age when assessed (years)
Alison	Female	ASC	Verbal	5:11	26	12
Robert	Male	ASC	Verbal	-	28	13
Gordon	Male	ASC	Verbal	-	18	13
Stuart	Male	ASC	Verbal	4:02	17	13
Chris	Male	ASC	Verbal	-	28/35*	13
Craig	Male	ASC	Verbal	3:02	32	13
Daniel	Male	ASC	Non-Verbal	-	23	8
James	Male	Asperger Syndrome	Verbal	-	19	8
Kevin	Male	ASC	Non-verbal	-	26	8

Table 8: Involvement of Child Participants (pseudonyms used)[2]

Name	Exploratory Studies	Studies to Inform Design	Formative Evaluation	Summative Evaluation
Alison *		✓	✓	✓
Robert *		✓		
Gordon *		✓		
Stuart *		✓		
Chris *		✓		✓
Craig *		✓		✓
Steven			✓	
Alan			✓	
Noah			✓	
Daniel *			✓	
James *			✓	
Kevin *				✓

[2] * indicates that the participant has a diagnosis of an Autism Spectrum Condition.

4.2.1. **Description of participants**

Adults

Amanda is a senior teacher within a primary school catering for those with recognised communication difficulties, with over 30 years teaching experience in both mainstream and specialist education.

Amy is a class teacher. She has two children with Asperger Syndrome in her current class. Her involvement in this research was her first experience of working with children with Autism Spectrum Conditions.

Damien is a usability consultant with five years industry experience in interface evaluations.

Dawn is a Support for Learning Assistant working in a specialised classroom for teenagers with Autism Spectrum Conditions. She has 7 years of experience working closely with children with special needs.

Heather is a Support for Learning Assistant working in a specialised classroom for teenagers with Autism Spectrum Conditions. She has over 25 years of experience working closely with children with special needs in a variety of settings.

Margaret is a class teacher at a mainstream primary school, which has currently enrolled five children with Autism Spectrum Conditions. She currently has two of these children in her primary 5 class.

Matthew is a primary school teacher within mainstream. He has over 10 years of experience working with children aged 5-10 years. He has particular interests in the development of literacy and the use of technology in education.

Natalie is a Depute Head Teacher in a mainstream school, which has currently enrolled five children with Autism Spectrum Conditions. She has previous experience in working with children with Autism Spectrum Conditions within a mainstream environment.

Rosalyn is a newly qualified Speech and Language Therapist, with approximately two years experience in an educational setting.

Ruby is a Depute Head Teacher at a special school catering for the needs of children with moderate to severe Autism Spectrum Conditions. She has previous experience of working in a school catering specifically for Autism Spectrum Conditions.

Sally is a teacher within a primary school catering for those with recognised communication difficulties. She has over 35 years teaching experience in both mainstream and specialist education.

Samantha is a Support for Learning Assistant working in a specialised classroom for teenagers with Autism Spectrum Conditions. She has over 15 years of experience working closely with children with special needs.

Sarah is a management-level Speech and Language Therapist, with more than 40 years of combined clinical and educational experience.

Simon is a usability consultant with five years industry experience in interface evaluations and web accessibility.

Yasmin is a teacher within a special school, working with teenagers with Autism Spectrum Conditions. She has over 10 years of experience with a post-graduate qualification in teaching for Autism.

Children

Alison is initially very shy when meeting new people. When she is comfortable in her surroundings, she becomes very vocal, often displaying directive social behaviour. Her verbal communication can increase when faced with unfamiliar tasks.

Chris has very limited vocabulary, and often displays challenging behaviours. He finds it difficult to regulate his emotions and has auditory sensitivities. He enjoys being in the playground, as this allows him to move around more readily than the enclosed classroom environment.

Craig is very shy and introverted. He rarely communicates verbally and appears timid. He often plays alone at lunch and break times, demonstrating repetitive behaviour. He seeks sensory activities related to touch and sound.

Daniel is aged 8 years and attends a special educational unit attached to a mainstream school. He has a diagnosis of mild to moderate Autism Spectrum Disorder which gives rise to special educational needs. He is particularly motivated by technology.

Gordon often appears shy and reserved, regularly displaying difficulties in initiating communication. He usually sits on his own at break time and does not interact with other classmates. Gordon finds it very hard to communicate that he has completed a task.

James is aged 8 years and attends a special educational unit attached to a mainstream school. He has a diagnosis of mild Autism Spectrum Disorder and attends some classes within the mainstream school. When meeting new people, he is particularly shy and quiet. He often requires encouragement to contribute to discussions.

Kevin is particularly motivated by technology and requires highly structured support to complete tasks. He communicates primarily through signing and displays challenging behaviour as a communicative intent.

Robert has sufficient vocabulary to communicate with his peers but often shies away from social situations during class sessions. He has a tendency to engage in echolalia[3] as a means of emotional regulation when in an unfamiliar situation.

Stuart uses limited vocabulary to communicate, often preferring to use sounds and gestures with familiar adults. He is proficient in using computers but has difficulties in expressing his frustrations.

4.3 Ethics

The first step of participant involvement in the research process is the consideration of ethical issues and gaining ethical approval (Molich et al., 2001). Ethics approval was sought and gained from the NHS Tayside Ethics Committee. The research methodology for development and evaluation of the sharing tool was submitted to the committee for review prior to the commencement of the research. The researcher underwent a police check and was issued a Disclosure Scotland certificate, which ensures that people working with vulnerable groups do not have a criminal history.

The research was conducted in adherence with the ethical principles outlined by the committee. All adult participants were presented with an information sheet, consent form and image release form. An opportunity was given to ask any questions they might have before the consent forms were signed. One copy was retained by the researcher, the other by the participant. For child participants, the parent or guardian was given a copy of the consent forms to be signed on behalf of the child. The information and consent forms given to parents of children with Autism Spectrum Conditions are included in appendix G. Assent was sought

[3] The repetition of speech produced by others. The echoed words or phrases can include the same words and exact inflections as first heard, or they may be somewhat modified; WILKINSON, L. 2010. *Best Practice Guide to Assessment and Intervention for Autism and Asperger Syndrome in Schools,* London, Jessica Kingsley Publishers.

from the child on an informal basis, since there were concerns from both parents and practitioners that they would not fully understand the consent process.

Whenever studies were conducted in schools, ethical approval was sought from Dundee City Council or Perth and Kinross City Council Education Board. This was in addition to the NHS ethics procedure and is standard practice when working in schools. Conditions of ethical approval were that a member of school staff accompanies the researcher when working with pupils and that the consent forms be sent to parents along with a letter from the school indicating their acceptance of the study.

The involvement of participants was paramount to this research. The debriefing of participants upon completing studies was important to ensure that the participant understood their participation and was given opportunities to reflect on the process. For adults, this comprised a short discussion whereby the researcher explained the outcomes of the research, frequently as a short professional or training presentation within the workplace. This allowed other staff members in the location who had not been involved in the study to find out more about it also. For children, the researcher attended school assemblies and each child was issued with a certificate of participation in the project. An example certificate can be found in Appendix B. The provision of these certificates allowed the participant a tangible reward for their efforts in participation. To ensure that parents were involved in the debrief process. A short letter was sent home, thanking them for their participation and giving a short account of their child's involvement. In some locations, this coincided with parent/school evenings which meant that the parent was able to watch video footage of their child's involvement, and experience which was often emotional.

Chapter 5. **Exploratory studies**

This chapter describes the initial studies undertaken which have determined the research direction of this thesis. Each study is described and the results are discussed. The chapter concludes with a focus on sharing and the identification of research questions, which are addressed in the remainder of this thesis.

Empirical research through an experience of the research environment is viewed in the literature as an integral phase of research, particularly where there is direct involvement of users (Keay-Bright, 2007b, Howson et al., 2004, Whaley et al., 2004). In addition, the participation of the researcher is invaluable in ethnographic methodologies (Pole and Morrison, 2003). In such methodologies, there is an emphasis on gaining knowledge by means of direct and indirect observation and experience, setting the research within a wider and often applied context. In this research, a variety of methodologies (including participant observations, interviews and focus groups) were employed in order to understand, explore and experience the practical implications of the research within the context of education and therapy of Autism Spectrum Conditions. This allows for the positioning of the research within the educational context and to ensure that this is clearly defined in a realistic setting (Pole and Morrison, 2003). There are also opportunities to map the literature to the reality experienced. On completion of these exploratory studies and associated background literature research, research questions are defined.

5.1 Participant observations

The researcher conducted participant observations in a variety of situations, including therapy sessions and educational contexts. These observations followed an ethnographic

approach, with the researcher being involved in the general activities of the day and, where possible, being integrated into the settings.

5.1.1. Aims of observations

The purpose of the observations was to consider the specific problems that occur in the school environment for those with Autism Spectrum Conditions and to gain an insight and understanding into how children with Autism Spectrum Conditions interpret events and interact with others around them. In addition, the observations can assist both in uncovering the best practice strategies currently in place to combat these identified problems and to relate these solutions to the literature.

5.1.2. Participants

The observations involved many participants observed in a number of settings:

- *Setting A*:

  A group of participants (n=16) were observed within a primary school catering for those with recognised communication difficulties as identified by local teaching professionals. Aged between 5-8 years old, the participants were educated in a structured environment based on the TEACCH program (Mesibov et al., 2005), attached to a mainstream primary school. Diagnoses included Autism Spectrum Conditions, Attention Deficit Hyperactivity Disorders (ADHD), learning difficulties and dyspraxia. Particular attention was paid to those participants with a diagnosis of an Autism Spectrum Condition. All participants were considered High-Functioning and were literate.

- *Setting B:*

  A group of participants (n=6) with Autism Spectrum Conditions were observed within a special school, in an autism-specific classroom. Aged between 12-13 years, the participants had a receptive vocabulary age of 3-5 years as determined by the British Picture Vocabulary Scale (BPVS) (Dunn et al., 2009), and associated learning difficulties. A range of augmentative communication techniques was employed including signing and the use of graphic symbols (e.g. PCS).

- *Setting C:*

  A group of participants (n=8) were observed during two communication group therapy sessions. Children aged 5-8 years were provided with opportunities to explore social skills and implement them in a safe environment. Children were also given the opportunity to explore different technology provided by the researcher including PCs, laptops and tablet devices. All participants had a diagnosis of Autism Spectrum Condition.

5.1.3. Materials

A Sony HDR-CX155 Handycam video camera was used. In addition, a note pad and pen were required.

5.1.4. Procedure

Observations followed an ethnographic approach and were conducted in a naturalistic setting, which can ensure that the behaviours observed are as close to typical for that individual as possible, given the presence of the observer. Furthermore, the participation of the observer avoids the use of second-hand information, which may, intentionally or

otherwise, be biased. In order to increase the chances of realistic behaviours being observed, observations did not have a pre-defined schedule. This allowed the researcher to gain an insight and understanding of how the participants perceive and interpret events and interact with others.

The recording of the observations was in the form of note taking after the event, with the researcher being involved in the activities, where possible. Field notes were completed in narrative form within one hour of the observations being carried out. Observation was flexible and responsive to events as they occurred with the aim being to observe and interpret patterns of behaviour, based on the current and immediate situation as well as the 'bigger picture'. Video recording of the sessions was avoided on the advice of teaching staff, since this could have been intrusive and distracting for the participant group.

The observation methodology is described in figure 4 and defines the observation along the four scales of observation outlined by Flick (2009).

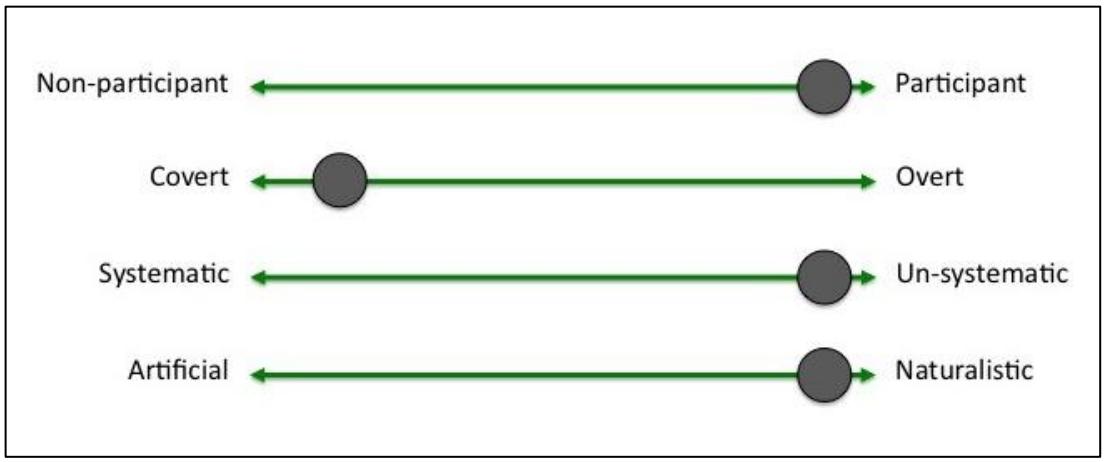


Figure 4: Observation scales (Flick, 2009)

The role of the researcher as an observer was identified to "gatekeepers" (teachers / therapists) but the actual role was concealed from the children being observed. Ensuring the

children were unaware of the researcher's role encouraged natural behaviours. However, as the teacher was aware of the research, this may have had an influence on her interaction with the children, albeit unintentionally.

Once the children had left the area, photographs were taken of objects of interest in the various settings. Care was taken to ensure that the children had left the area and so were not distracted by the camera.

5.1.5. Results

Description of settings

The settings of the observations were highly structured, based on the principles of the TEACCH approach (Mesibov et al., 2005). Each time the children arrive at the location (either school or NHS centre) the adult in charge provides an overview of the timetable to be followed. The timetable consists of laminated cardboard strips with symbols representing different activities arranged in order for that day and attached by Velcro. After each task, that activity is removed, so that only the current and upcoming activities are shown. Figure 5 shows an example timetable from setting B.

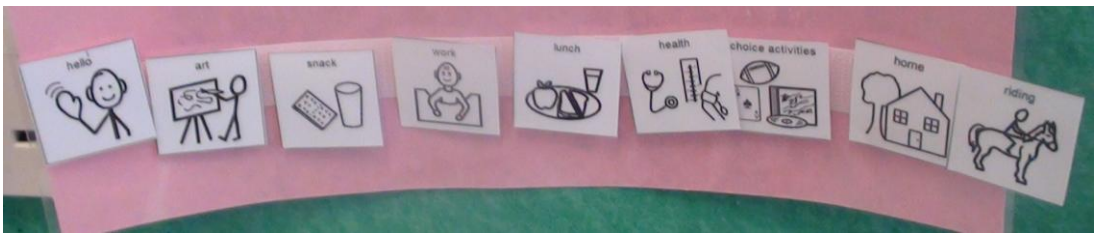


Figure 5: Sample visual timetable

Having this consistent start to the day or session provides stability and routine, helping to settle the child and to relieve any residual anxiety. Ensuring that all activities have the same

start and end point supports this routine. For example, group activities in setting A begin and end with reference to an emotion chart, as shown in figure6. This visually displays a spectrum of emotions (numbered 1-5) and participants were invited to signify their current emotional state at each point. This provided a learning opportunity for the participants, ensuring that the children have opportunities to explore and express their emotions, and develop their recognition of self, a current area of focus in the school curriculum (Scottish-Executive, 2004). Where emotions differed considerably between the start and end of an activity, the adult in charge engaged in discussion with the child. This discussion was centred on the changing emotions, the cause of such, and the potential actions that can be taken by the child, e.g. "*During that activity I got really angry because I didn't understand it. I can go to the quiet area to cool off and then try again*". This discussion occurred more often with those participants who were high-functioning.

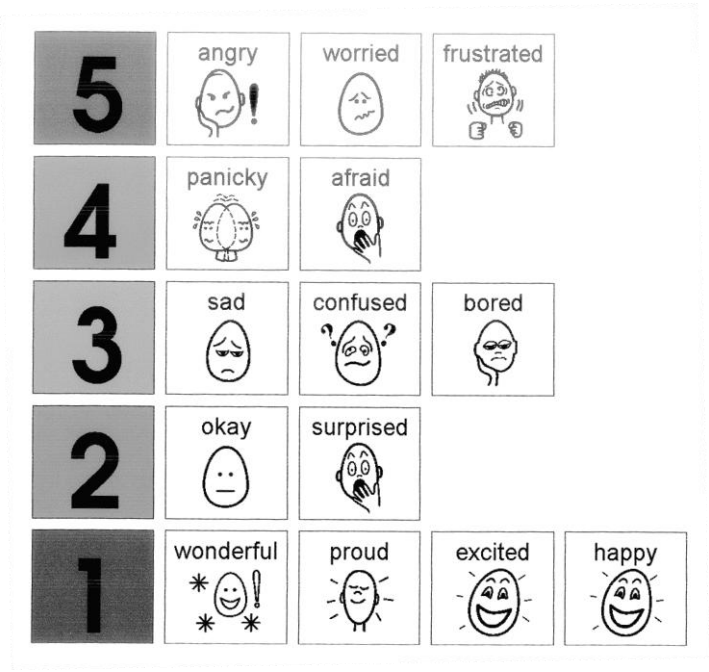


Figure 6: Emotions chart

Further visual scales observed in setting A included the voice chart (see figure 7). As previously described, the numbers 1-5 forms a scale, which in this case was used to assess

the appropriate noise levels, encouraging children to use the correct vocal level in the correct setting. For example, this is a reminder that shouting is acceptable outside, but not in the classroom.

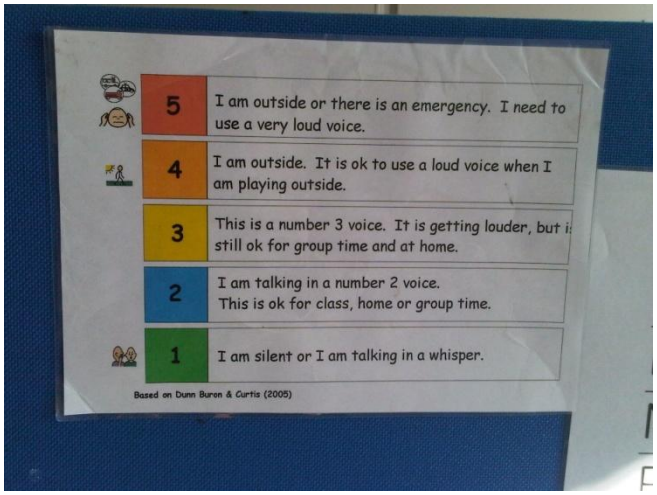


Figure 7: Voice scale

Within the school settings, the physical space was set up in a specific way, which attempted to minimise the sensory inputs of the environment and thus reduce the potential for distraction. For example, the work area is kept clear of objects unrelated to the activity, and are often blocked off from other classroom areas as seen in figure 8.

Figure 8: Example workstations (setting A, left; setting B, right)

The use of technology

The primary use of technology across the school settings was as a reward tool, providing an incentive to exhibit appropriate behaviours. Time at the computer was awarded for decreases in challenging behaviours (e.g. tantrums, biting), increases in appropriate social behaviours (e.g. saying 'please' or 'thank you') and for academic successes, such as completing worksheets or answering a number of questions correctly.

In all cases, the computers used were a standard PC setup (see figure 9 for an example of the setup in setting B). This comprised a monitor, keyboard and mouse. The screens were arranged such that the teacher was able to see the screen from anywhere in the classroom in order to ensure safety and security.

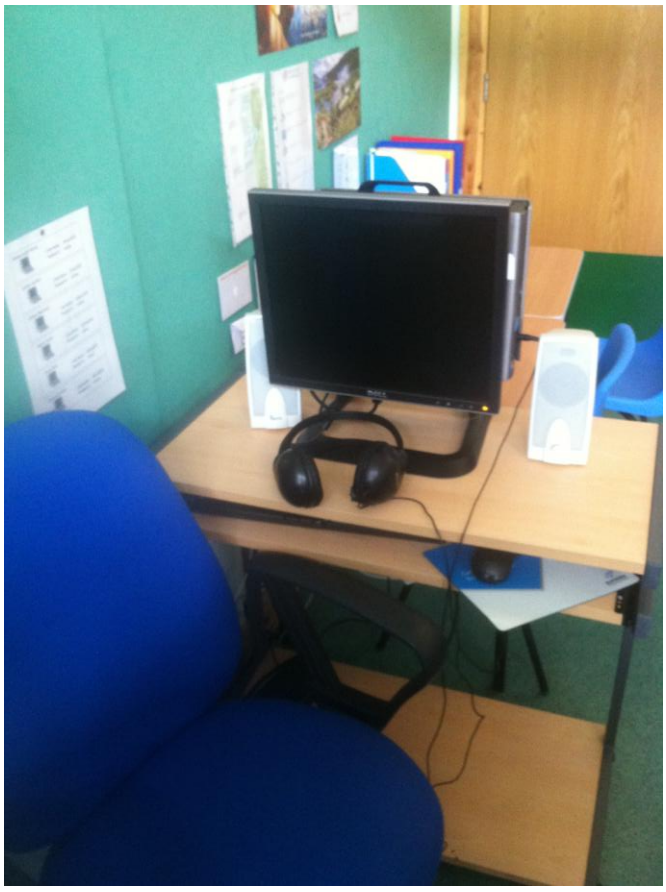


Figure 9: Computer setup in setting B

Typically, the use of the computers across all settings was to play games. Mini-games found on the Cbeebies website (http://www.bbc.co.uk/cbeebies) were particularly popular. All

participants were capable of loading the Internet browser and navigating to the appropriate web page, even though many did have some levels of difficulty controlling the mouse. For example, one participant in particular used two hands to control the mouse and another participant often became frustrated because he over-shot icons he wished to click on. Conversely, some participants were very proficient and upon further questioning, were discovered to play games consoles frequently at home, with one participant being noted by parents and teachers alike for his proficiency and skill using technology in a variety of settings including home, school and play environments.

In setting B, technology is also implemented in the form of a SMART whiteboard. This whiteboard is an interactive solution for collaborative learning, providing another opportunity to practice and reinforce social skills in a group setting. While there are numerous programs available for this relating to science, numeracy and literacy, there is no software available in these settings that allows children to directly explore social skills. Instead, the teacher must use the sessions to model appropriate social behaviours and encourage her pupils to engage in these socially acceptable behaviours.

Appreciation of spectrum of difficulties

Spending prolonged time periods in these settings has led to the researcher gaining an appreciation of the Triad of Impairments (Wing and Gould, 1979) and the specific difficulties encountered by those with Autism Spectrum Conditions in a variety of settings, such as one-to-one with peers or teachers as well as groups.

Difficulties in Social Communication abilities incorporate difficulties in understanding and utilising non-verbal cues, such as gestures, facial expressions, tone of voice and the use of abstract language. Specifically, participants failed to maintain eye contact with researchers, teachers or peers. Eye contact amongst the participants was limited and declined as the

social group increased in size. In a one-to-one situation such as when the teacher was speaking to an individual, there was a reasonable amount of eye contact, although this still appeared to be noticeably less than seen in typically developing children. However, when the child was speaking to the researcher in a one-to-one situation, there was markedly less eye contact than when interacting with the teacher. This suggests that the children have learned to look at a person when either speaking to them or listening to them, but have difficulty in generalising this to other people whom they are not familiar with.

In order to promote comprehension of verbal instructions, symbols or signing was used. Makaton signing (Makaton, 2011) was used frequently in settings B and C to reinforce verbal instructions, or to encourage interactions. One participant, who is primarily non-verbal, appears to comprehend and respond well to instruction when accompanied by Makaton signing, rather than verbal instruction alone. During the course of the observations in setting B, Makaton signing was successfully introduced to another participant as a means of initiating conversations, such as indicating when allocated worksheets were completed.

Social interaction was noted as a particularly difficult area for the participants. For example, participants in setting A were observed during negative integration with mainstream peers. Negative integration is where typically developing peers from the attached mainstream school visit the communication unit during free-play sessions. During these sessions, there was a clear lack of imaginative play, even in activities such as drawing, building with construction materials of playing in the sand, where there are ample opportunities for imaginative play. Instead, activities were based around construction and creation, where things created were based on real-life objects or pictures the child had seen. This was also seen in setting A, during Theory of Mind activities in therapy sessions where the participants were asked to determine a character's emotion and thereafter develop an imaginative story to suggest why the character feels that way. Most participants had difficulties with this task.

This may be because the participant does not understand the task, understand the emotion or simply because the participant was unable to convey this emotion.

There were also numerous opportunities to play with a set of dolls and a fantasy castle. This was a popular choice for the mainstream children but was not selected by the participants. When the participants did participate in playing with these objects, they exhibited parallel play as opposed to collaborative play. This means that the participants played independently alongside one another rather than interacting during the play activities, a common feature of Autism Spectrum Conditions (Attwood, 2006). In addition, participants with Autism Spectrum Conditions exhibited highly repetitive behaviours, such as continually spinning a ball or tapping on the desk. This is consistent with reports in the literature (Murray et al., 2005), which highlight the monotropic nature of Autism Spectrum Conditions, where attention is focussed intently on one specific or limited interest.

The rigidity of behaviour and thought processes in Autism Spectrum Conditions were also observed. The environments in all settings were highly structured through the use of visual prompting, timetabling and clear routines. This difficulty also came to the fore in times of change. The participants required frequent reassurance, for example before holidays or changes in routine such as specially arranged assemblies or trips to external locations. In these situations, strategies such as social stories (Gray, 2004) were relied upon in order to relay important information in a comprehensible medium and attempt to relieve anxiety experienced by the participants.

Difficulties in sharing

During the observations, difficulties in sharing were noted frequently, with sharing behaviours not being instinctively displayed by the participants. Despite therapy sessions being explicitly focussed on sharing abilities, the participants failed to display socially

acceptable sharing behaviours, despite opportunities being presented to do so. In one case, two participants in setting C were involved in a colouring activity; the participants were asked to share the pens. The participants failed to share the pens, with one child keeping possession of all the pens. Another common situation that occurred across all settings was the sharing of toys during play activities. This was most often seen with toys such as Lego, where one child would frequently commandeer the whole set of toys, an action which frequently led to conflict, particularly when these objects were preferred by one, other or both of the children.

Furthermore, specific activities based around snack-time in therapy sessions were focussed on having a number of food items such as sweets divided amongst the participants, particularly in setting C. Children were given opportunities to share plates of biscuits and pour drinks for others in the group. This focussed on the division of objects, but was rarely successful. Success did occur, but only when the children in the group were heavily prompted.

5.2 Interviews

Ethnographic, un-structured interviews were conducted with teachers, support for learning assistants (SLAs) and speech and language therapists (SLTs). These interviews were conducted in a variety of therapeutic and educational settings.

5.2.1. Aims of interviews

The purpose of the interviews were to consider the specific problems that occur in practical settings for those with Autism Spectrum Conditions, gaining an insight and understanding into how adults can assist children with Autism Spectrum Conditions in developing social

skills. In addition, the interviews aimed to uncover specific difficulties experienced by children with Autism Spectrum Conditions and the best practice and practical strategies to combat these identified problems and to relate these solutions to the literature.

5.2.2. Participants

The interviews were conducted with a number of participants who had a variety of career histories, practical experience and theoretical knowledge. The participants were:

- Rosalyn
- Sally
- Sarah
- Yasmin

This participant group comprises a mix of teachers and Speech and Language Therapists. Full participant details can be found in Section 4.3.

5.2.3. Materials

A Sony HDR-CX155 handy cam video camera, note pad and pen were required.

5.2.4. Procedure

Unstructured interviews were conducted, based on ethnographic methodologies, allowing for free exploration of the topic area. The interviews were based on a list of topics pertaining to the aims of the interviews, namely:

- The specific difficulties encountered in Autism Spectrum Conditions
- The practical implications of these difficulties
- The current best practice of Social Skills interventions
- Considerations of future interventions

The unstructured nature of the interviews acknowledges the expertise of the interviewee, allowing them to direct discussions with minimal intervention from the interviewer. Discussions are flexible, with the narratives allowing for the provision of highly detailed information from the expert interviewees.

All interviews were video recorded and transcribed. The transcriptions were then summarised by the researcher, based on the previously noted aims of the interviews.

5.2.5. Results

The interviewees described a variety of interventions used to combat social skills difficulties. These included comic strip conversations, role play, music therapy, massage therapy and sensory experiences. However, the most commonly used therapy was social stories. These social stories took many forms, for example, written stories, images, and multimedia or group discussions.

The interviewees also noted that a great deal of time was spent customising interventions for each child in order to promote engagement. This was considered to be necessary since children learn at different rates and each child has different knowledge and life experience. In addition, children with Autism Spectrum Conditions display special interests, often to the detriment of their learning and education. The child may not be focussed on the purpose or content of an intervention, as they are highly engrossed in the object of special interest. One

child was described as being unable to turn take with a partner in a ball throwing activity because they were focussed on spinning the ball (an object of interest).

While these special interests clearly have disadvantageous aspects, there are also aspects that can be used to the advantage of the child and the intervention. Children with Autism Spectrum Conditions are highly motivated by their special interest and so creating an intervention that caters to this interest can be highly valuable. This is often incorporated when considering positive reinforcement and rewards for participating in interventions, as these special interests provide motivation.

In addition to customisation, generalisation is an area that requires a great deal of time and resources. The generalisation of skills from therapy to reality is very difficult for those with Autism Spectrum Conditions, and is seen in the entire current cohort taught by the interviewees. This difficulty typically occurs because there is a discontinuity between the specific therapy environment and the natural, real-life application of the skills and behaviour. There is a balance to strike between making images and content generic (so not only to be applied to the specific therapy situation) and this content becoming too abstract to be comprehended by the individual and therefore is not applied to real-life situations.

There are a number of ways that teachers and therapists try to overcome the difficulties experienced in generalisation. For example, positive reinforcement is often used when the individual shows a learned behaviour in the natural environment. In addition, there is a continual reference by the teaching staff to the skill being taught (often using social stories). This can help the child bridge the gap between therapy and reality, but utilises a great deal of time and resources. There is also a risk that the therapy can become too focussed on one skill and so others are neglected.

One of the most successful methods of learning social skills as indicated by all interviewees is the learning of these skills in a real-life situation and context. For example, going to the

local library to borrow books gives opportunities to ask for help, interact with novel adults and for peer interactions.

The interviewees were asked to describe the main difficulties that they observe in Autism Spectrum Conditions and to indicate the skills they are currently focussing on with their cohort. Common areas of focus were initiation, generalisation, taking turns and sharing. In addition, the need to exploit technology in meaningful ways was highlighted. One teacher (Yasmin) regularly uses SMART whiteboard technology for literacy and numeracy, with very positive results. Students are focused and motivated to participate in the classroom activity, with the SMART board forming an excellent reward tool also. Using the SMART board allows the teacher to facilitate class discussions and to encourage children to participate who may ordinarily be averse to group work.

Current focuses of therapeutic interventions were also discussed. Yasmin and Sally emphasised the role that sharing skills play in their classroom and the difficulties they have in encouraging the children to engage in these behaviours. This was commonly seen during play activities where objects, such as drawing materials or Lego, need to be shared amongst a group of two or more children. The interviewees indicated that the children required extensive and continual prompting from the supervising adult in order to engage in play without conflict. Commonly the children tried to keep all the objects for themselves and appeared unaware of the other children who were wishing to use the objects. This led to frequent confrontation, as the children were either unaware, or unable to implement, the "social conventions" of play and so experienced anxiety and stress as a result. Where the children considered the objects desirable, such as an object related to a special interest, the levels of sharing seen declined further.

5.3 Discussion

Ethnographic observations and unstructured interviews have highlighted the difficulties experienced by those with Autism Spectrum Conditions in learning and implementing social skills across a variety of settings. When a skill is learned in the therapy setting, the application of that skill in reality is often lacking. The generalisation of skills learned is an area of focus for teachers and therapists, in order to ensure that therapeutic interventions can have a positive implication in the life of an individual with an Autism Spectrum Condition. This is done in a number of ways including role play, prompting and the exploitation of learning opportunities in the real-world environment.

Technology is highly motivating for pupils with Autism Spectrum Conditions, but it is under-utilised at present. The SMART board in particular, provides opportunities for collaborative learning and peer-to-peer interactions in way that is motivating and engaging for individuals with Autism Spectrum Conditions. However, there are no specific programs available for exploring social skills being used in these settings or by any of the interviewees.

The provision of a structured learning environment that provides opportunities for visual learning was also considered. This is important, since structure and routine cater for the rigidity of thought and behaviour seen in Autism Spectrum Conditions. Through mediating these needs, the anxiety experienced by an individual can be decreased, thus allowing them to focus and engage with the current learning opportunities presented.

Sharing was highlighted repeatedly in interviews as being a particular area of difficulty, with children tending to keep the maximum number of objects for themselves, particularly when the object was desirable. The knowledge of sharing skills in Autism Spectrum Conditions is explored in the remainder of this chapter.

5.4 Focus on sharing

The importance of social and communication skills have long been emphasised as the basis of learning by all children (Piaget, 1962, Scottish-Executive, 2004). One of these skills, sharing, is a *"prosocial skill associated with the development of positive social relationships"* (DeQuinzio et al., 2008). Much of the exploratory research described in this chapter has highlighted the difficulties in sharing experienced by children with Autism Spectrum Conditions. This has warranted further investigation of both the typical development of sharing behaviours and current research into this when considering the population with Autism Spectrum Conditions.

Sharing occurs naturally in the typically developing population (Tremblay et al., 1981), observed in very young children in behaviours such as showing and bringing (Rheingold et al., 1976). From the age of 3-4 years of age, children begin to understand sharing through the establishment of their identity, testing boundaries and standing up for their rights within their peer group.

Individuals display sharing behaviours for a variety of reasons, which often depend on the circumstances in question. As the basis of many friendships, children may share items of importance, such as toys, to develop a bond and mutual respect. In many cases, this can be seen in terms of reciprocity, whereby an act of sharing by one individual can result in a reciprocal act of sharing by another (van den Bos et al., 2010). This reciprocity is necessary to maintain social relationships, since a lack of such may result in short-lived relationships and friendships (Lahno, 1995). Reciprocity may be immediate or delayed and this will depend on the development of trust within a given relationship, along with the cognitive development of the individuals involved (van den Bos et al., 2010). Sharing behaviours can also be identified in relation to social responsibility, conformity, the avoidance of conflict and the rule of law.

Sharing has been highlighted as an area of difficulty in Autism Spectrum Conditions (Attwood, 2006) and this can be largely attributed to poorly developed Theory of Mind abilities. For example, there may be no understanding or interpretation of social cues that would initiate sharing, such as eye contact or pointing. In addition, the person concerned may not realise that the sharing partner desires the object in question and so may appear rude by apparently refusing to share. However, it is also possible that the child is aware that their social partner wishes an object but has no reason to share, as they lack sufficient motivation to do so (Prizant and Rubin, 1999).

There is a variety of intervention methods used in addressing the difficulties seen in social skills, such as social stories, comic strip conversations and video modelling (Kuoch and Mirenda, 2003, Sansosti et al., 2004, Simpson et al., 2004, Bock et al., 2004), with mixed results across a range of studies. However, studies that focus specifically on sharing are limited, with sharing often considered as a side-issue. For example, Barry and Burlew (2004) identified sharing as being an important element of playing with peers, although the main focus of the study was making choices. Social stories were used as an intervention with two children diagnosed with severe Autism in a special education setting. Concerning sharing, the results were mixed, with one of the two participants showing an increased awareness of peers, engaging in appropriate interaction and play. However, the extent to which sharing behaviours improved was not explicitly discussed suggesting that improvements were not substantial.

Another study has investigated social skills including, but not limited to, sharing (Kamps et al., 1992). Social group lessons were conducted during play sessions in an intensive schedule of 10 minutes per day, 4 days per week over a six-week period. The participants were pupils in a mainstream class; three children with Autism and eleven of their typically developing peers participated in the study. The participants with Autism were assumed to be

high-functioning as indicated by their intellectual abilities. Through a multiple baseline design across children, the results show positive changes in social behaviours across both groups of participants. However, like the study by Barry and Burlew (2004), specific changes in sharing behaviours were not reported.

Two studies have been identified that focus specifically on sharing skills, rather than a wider spectrum of social skills (Simpson et al., 2004, Swaggart et al., 1995). Swaggart and colleagues (1995) worked with three children with moderate to severe autism aged 7-11 years. Of these three children, two were read social stories at the beginning of each day pertaining to sharing (the third participant focussed on a different social skill). School staff used verbal prompts and reinforcement throughout the day to encourage the participants to make use of the sharing skills outlined in the social stories. Both participants showed an increase in sharing behaviours, increasing to display those behaviours at 22% and 35% of opportunities. However, the quality of these sharing behaviours was not considered, with the data gathered being purely qualitative.

The second study focussing on sharing skills was that conducted by Simpson et al (2004), which aimed to evaluate the effectiveness of computer-based instruction (CBI) using video-modelling, to teach specific social skills to four participants with autism. As the only noted study that focuses on sharing through the use of computing technology, this was similar to the work conducted by Sansosti and Powell-Smith (2008), which focussed on social skills including joining and maintaining conversations. In both cases, computers were used as a vehicle to display a social story to the participants, followed by a video representation of that skill being utilised by a peer (Simpson et al specify that the peer was a typically developing age-matched peer). The specific social skills addressed by Simpson et al include sharing with others. The social story for this includes the phrases *"sharing means to let others use your things"* and proceeds to describe sharing a pencil during a maths lesson before this is

modelled in the video. Four participants, aged 5-6 years, with mild to moderate Autism took part in the study. All participants spent at least part of their day in mainstream schooling and interacted with the CBI for 30 minutes each day, with minimal interaction with staff. The effectiveness of the CBI to teach the participants about sharing was evaluated by videoing small group classroom activities and coding for the target behaviours. All participants showed increases in the frequency of sharing behaviours displayed following the introduction of the intervention. However, unlike Sansosti and Powell-Smith (2008), the authors did not conduct generalisation probes to assess whether the newly displayed behaviours were transferred to novel settings.

Through exploratory research and literature review, it has been noted that social skills, in particular, sharing has been identified as an area of specific difficulty for those with Autism Spectrum Conditions. Considering the above noted studies, approaches to assist children in exploring sharing skills, and generalising these skills to reality are lacking. Current solutions including social stories and social groups have yielded some positive results but, overall, these approaches have not always been successful. Furthermore, these approaches have not focused on the potential of generalisation for the development of sharing skills.

In order to address this need, a tool is proposed that will support children with Autism Spectrum Conditions in the acquisition of sharing skills and provide opportunities for the subsequent generalisation of these behaviours. The affinity for technology displayed by this group is crucial in the proposal that technology may provide a solution to assist this user group in acquiring sharing skills. The research will focus on providing an opportunity for the involvement of stakeholders including children with Autism Spectrum Conditions in the design and development of this system, followed by evaluation of the sharing tool.

5.5 Research questions to be addressed

The following research questions are proposed, with the research focussing on these being found in the subsequent chapters of this thesis.

1. Can social skills, in particular sharing, be improved in children with Autism Spectrum Conditions through the use of a computer-based tool designed specifically to support this?
2. Does any knowledge or skills carry through to a wider social context?
3. How can children with Autism Spectrum Conditions participate in the design process and what are potential outcomes of this?
4. What can practitioners contribute to the design process and what is the impact of this?
5. What do practitioners learn through contributing to the research evaluation?

Chapter 6. **Studies to inform design**

This chapter describes the process and methodologies employed in understanding the topic area of sharing, designing the interaction and designing the interface. During the studies described in this chapter, the development of many low-fidelity prototypes was iterative, with mid-fidelity prototypes such as interactive PowerPoint slides being used to illustrate the interaction of participants with the system.

As a result of the iterative design work conducted in this chapter, a high fidelity prototype was created, which was evaluated and further developed in Chapter Seven. The final system is described in Chapter Eight.

6.1 User involvement

User participation in research is crucial if the research is to have a significant impact on the environment in which it is situated (Wadsworth, 1998). This is particularly vital when the end-users have special needs or developmental disabilities such as Autism Spectrum Conditions (Fischer et al., 2002), as it can be difficult to engage such individuals outwith their own range of special interests (Gagnon, 2001). Furthermore, children with Autism Spectrum Conditions may interact with their environments in ways that their typically developing peers do not (Prizant et al., 2006). Ensuring their involvement, alongside other stakeholders, at all stages of the research will assist in ensuring that the resulting technology is both usable and purposeful.

Requirements gathering is a multi-disciplinary and human-centred approach (Nuseibeh and Easterbrook, 2000), which focuses on defining the specifications of the end product. The gathering of requirements is a crucial process in the development of technology, both for the

design and final implementation of an end product, regardless of the software development cycle used. Successful requirements must take into account the ‘bigger picture’ and consider the environment in which the system will operate (Holtzblatt and Beyer, 1995) as well as the abilities, knowledge and aims of the end user. Kotonya and Sommerville (1998) highlight the importance of understanding the application domain, taking into account the user’s surroundings. Indeed, where the user is the main source of information leading to requirements, there are often fewer development iterations in the software development (Chatzoglou and Macauley, 1996), since fewer changes are required due to the early user input.

The greatest number of errors in a software development occurs in this early stage of requirements gathering (Flynn, 1992). These requirements are the basis upon which the system is built and developed; consequently the cost of eliminating these errors during the system maintenance phase is considerably higher than that for errors in other areas, such as the design or coding and implementation (Ehrlich and Rohn, 1994). The cost (e.g. financial, time spent) involved in making changes to the requirements during the system development and implementation increase’s with time (Noyes et al., 1996). Therefore, ensuring the requirements are correct is vital to the success of a development project.

The software used in this research has been designed and developed with input from stakeholders throughout the process. Each iteration involved input from at least one stakeholder group, with methodologies frequently being adapted to accommodate this.

6.2 Stakeholders

Four user groups have been identified as stakeholders in the research. The following section describes each of these groups and the potential role that the stakeholder group can play.

Children with autism spectrum conditions: This stakeholder group has been identified as the main set of users for the software system being developed. The children within this stakeholder group cover a spectrum of abilities related to Autism Spectrum Conditions, from non-verbal low functioning children with classical autism, to high functioning children with Asperger Syndrome. All users in this group are noted to have difficulty in exploring social skills in practical situations. This includes a limitation in the ability to share.

Ensuring a wide representation of different sub-groups ensures that the participants best reflect the heterogeneous nature of Autism Spectrum Conditions experienced in reality. Software design methodologies will be adapted so that this participant group is provided with opportunities to contribute meaningfully to the design and development of the sharing software.

Typically developing children: This group comprises children of a developmental level similar to those with Autism Spectrum Conditions. Children within this group are likely to be chronologically older than the children with Autism Spectrum Conditions when compared using developmental measures. Also, children in this group are expected to attend mainstream education.

The development of social skills does not follow a steady trajectory (Pennington et al., 2007) and so typically developing children may be able to make use of the software.

Furthermore, this group is considered more likely to engage creatively with software design methodologies than their peers with Autism Spectrum Conditions, by constructively articulating design suggestions and making informed design choices.

Practitioners: For the purpose of this research, practitioners comprise teachers, school staff and Speech and Language Therapists (SLT), who may be currently involved in education pertaining to the development of social skills. This group can provide a wealth of experience and opinions that can then be translated into design specifications. This group contains experts in interacting with children with Autism Spectrum Conditions who can provide advice and rationale for developing potential interactions with the software, as well as providing practical advice where required.

Parents and caregivers: Parents are considered to be experts in their own child's behaviours, skills and abilities (Prizant et al., 2008a). Consulting this stakeholder group will give rise to an abundance of high quality data regarding the individual children being considered. This will include both successful strategies already in place to overcome difficulties and the practical implications of such strategies.

6.3 Studies to inform the design of the sharing tool

The studies completed as part of the design are summarised in figure 10. Each study is described before all results are combined and reported in Section 6.4.

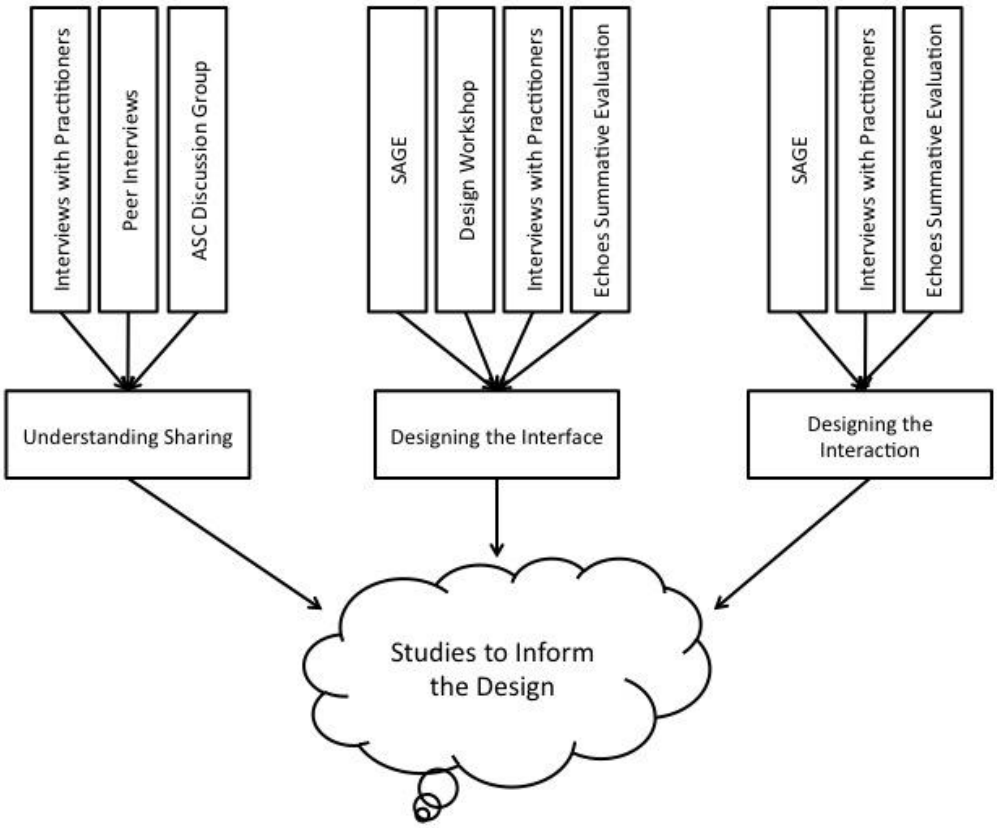


Figure 10: Studies that informed the design of the sharing tool

6.3.1. Special Advisory Group for Echoes (SAGE)

The Special Advisory Group (SAGE) incorporates individuals who were invited to assist the Echoes research team to develop a functional and usable system that can be used by children with Autism Spectrum Conditions to explore social skills. This advisory group comprises a spectrum of individuals including Speech and Language Therapists, teachers, psychologists, parents and children with Asperger Syndrome.

Throughout the development of Echoes, SAGE met three times, as part of the work to design the Echoes system. This section focuses on the first SAGE session, in which the author of this thesis was involved as a facilitator. This involvement was particularly advantageous as it provided exposure to a wide range of participants who afforded the benefit of their often-extensive experience. The purpose of the SAGE meeting for Echoes was to gain the input of the expert advisors in a number of areas: namely gathering requirements for the interaction aspects of the system and the realistic involvement of practitioners in the system. Outputs for this thesis include determining requirements for the design of the interface and interaction.

Participants

A total of sixteen participants were involved in the first SAGE meeting, in addition to seven members of the Echoes research team who presented Echoes to the group. The participants comprised psychologists, teachers, speech and language therapists and experts in ICT support for children with Autism Spectrum Conditions. Also present was a teenager with Asperger Syndrome and his mother, both of whom contributed to discussions. The participants were geographically located throughout England and convened at the University of Birmingham.

Materials

Paper and pens was supplied to all participants. The current Echoes prototype was also used, comprising a PC, monitor, keyboard, mouse and touch screen (see figure 15). Multiple video cameras were used to record the session.

Procedure

The first SAGE meeting lasted one day and was conducted at the University of Birmingham. This session, along with subsequent sessions, were video recorded for later analysis. Firstly, senior members of the research team outlined the purpose and activities of the day. This included PowerPoint presentations, which outlined the aims and objectives of the Echoes project to the attendees.

After an introduction, the attendees were split into smaller groups of approximately 5 people, with the goal being to explore the role of technology in the classroom including any concerns that the group may have about this. Each group was assigned a researcher, who adopted the role of facilitator. Participants were encouraged to provide their own opinions of technology in the classroom and to share any experiences they might have.

Participants then gathered as a whole group and were introduced to the Echoes system. This comprised an overview presentation and the current prototype was shown to the group. Through interactions with this prototype, the participants were able to experience Echoes for themselves and to gain an understanding of how such a system may operate. Subsequently, the participants split back into smaller groups to further consider the Echoes system. Participants were asked to think of children they were currently working with. The facilitators encouraged discussions around both how the system might respond to the child and how the child might interact with the system.

The final session of the day was a large group discussion exploring how Echoes may be used in the classroom. Discussions were focussed on the practicalities of how such software may be implemented in the classroom and the needs of the practitioner within the Echoes environment.

Results

The importance of encouraging participant engagement with the sharing tool was discussed in depth during the SAGE workshop. Having an opportunity for customising the interface was considered an important method of securing this engagement by many participants. However, there were concerns this customisation may go too far. For example, spinning objects may attract a given child to the system but could ultimately become a distraction and a barrier to learning. An inclusion of familiar objects may encourage the child to interact with the system, particularly for children with Autism Spectrum Conditions who may be averse to changes and new experiences, but should be kept to the minimum level necessary. In a similar vein, the consistency of the interface can reassure the participant by responding in a predictable manner to help reduce anxiety.

6.3.2. **Interviews with practitioners**

Practitioners have a wealth of professional experience and knowledge of Autism Spectrum Conditions. Throughout the design phase of the research, this knowledge was gathered both through discussions of their experiences and their subsequent involvement in co-design which verified existing designs and design concepts, while expanding these into new paradigms where appropriate.

Interviewing is considered to be crucial in the implementation of User Centred Design methodologies. Through careful interviewing with varying levels of structure, researchers can gain a greater understanding of the user needs and concerns, their environment and, ultimately, their interaction with that environment in ways that can be meaningful for the development of research and design (Patton, 2002). These levels are defined as structured,

semi-structured and unstructured (Fontana and Frey, 2005) and can be utilised throughout a research project (Lazar et al., 2010).

Interviewing was selected as the primary method to elicit requirements from the practitioners and to evaluate current designs. The original intention was to include a series of Focus Groups, but since the practitioners involved in the research worked in different roles and in different locations, their individual timetables did not allow for a group meeting. Therefore the decision was made to include only interviews, allowing for individual discussions of the design concepts. Where appropriate, during these sessions, the researcher represented an overview of anonymised opinions gathered from other participants.

Participants

All participants had experience of working with children with Autism Spectrum Conditions either as a teacher or as a Speech and Language Therapist. The participants[4] involved in this study were:

- Amanda *
- Rosalyn
- Sally
- Samantha *
- Sarah
- Yasmin

Full participant details can be found in Section 4.3.

[4] * denotes that the participant has not previously been involved in the research.

Materials

For some sessions, low fidelity prototypes (screenshots) and mid fidelity prototypes (storyboards) were used, along with post-it notes, coloured pens and blank paper. An audio recording or video recording device was used to record the sessions.

Procedure

Sessions were conducted within schools, either during lunch breaks or after classes. Participants were interviewed separately where possible, for periods of up to 30 minutes. During initial interviews, the researcher asked questions related to current ICT use by interviewees. The participants were asked to provide examples of ICT, which they considered to be well designed and successful in an educational context. Participants were particularly encouraged to think of programs related to the development of social skills. Subsequently, the participants were shown low fidelity screenshot prototypes developed by the researcher and encouraged to provide critical feedback of the proposed interface, based on their own experience and knowledge of children with Autism Spectrum Conditions. This feedback varied between giving verbal feedback and drawing or adapting sketches, including adaptations to the original screenshot prototypes and developing new screenshots.

During the second phase of interviews, the interaction of the user with the sharing tool was explored. The researcher presented mid fidelity storyboards (created using Microsoft PowerPoint) to provide a starting point for discussion. Participants were then invited to contribute to co-design by suggesting changes, which show the possible interactions of the child with the system. Participants were encouraged both to adapt the existing storyboards by drawing on them with the pens and to indicate possible changes using the post-it notes. In addition, participants were encouraged to provide their own suggestions by using the blank

paper to illustrate their ideas. Participants were requested to think of different children they frequently worked with and to consider how each child might react to the system. For each session, participants were encouraged to consider no more than two personas based on their own experiences in order to encourage precise and detailed feedback with concrete examples.

Results

Practitioners indentified sharing as being the basis of peer to peer interaction and a main focus of their efforts in the classroom. In order for children to experience success in the realm of social interaction, practitioners consider a two part approach. Firstly, the child must be aware of the skill in question and, secondly, be aware of the potential applications of the skill. Only when these two aspects are fully appreciated, will generalisation be achieved. Further, practitioners indicated that the repetition of skills is key for social success.

The time spent customising interventions is massive for practitioners within education, and is extremely time-consuming. In particular, practitioners suggested that the structure of interventions must be customised for each child. The customised structure should include timetabling and timing strategies, such as ensuring that a clear end-point of activities is indicated. This end point should not be time-based for the sharing tasks, as this is likely to increase anxiety and stress.

The consistency of the system in reflecting teaching methods and vocabulary currently used in the classroom is considered by practitioners to also be of importance. This includes the use of signing systems used to augment communication, and the use of specific vocabulary, such as using the participant's name frequently, e.g. "Rachel's turn". Finally, it was noted

that the use of the system must be without distractions, in keeping with the SCERTS philosophy (Prizant et al., 2008a), currently being employed by practitioners.

6.3.3. **Peer interviews**

In some cases, traditional interviews may be difficult to conduct and so can lead to the researcher not fully understanding the problem space. For example, this may occur when the interviewee is reluctant or unable to provide full answers to given questions (Breakwell et al., 1995). The interviewee may omit information, either on purpose or, more often, because they do not value the information as being appropriate and informative to the software development.

In particular, there are a number of limitations that have been found when working with children. For example, children may not fully understand the question-answer process (Borgers et al., 2004) and can be keen to give the "correct" answer and thus please the adult researchers conducting the interviews (Good and Robertson, 2006). In addition, children may find it intimidating to talk to a stranger or unknown interviewer (Hill, 1997). In the case of requirements gathering, interviews are intended to be exploratory. As such, there is no correct answer, and so the true opinions of the group being considered (i.e. children) may not be reflected. This desire to please may result in anxiety. Good and Robertson (2006) suggested that peer interviews could reduce such anxiety. Furthermore these limitations can be more pronounced in individuals with Autism Spectrum Conditions. A lack of social imagination means that those with Autism Spectrum Conditions may be averse to social communications (including an interview) with an unfamiliar adult, such as the researcher, which can lead to further increased angst and stress. In addition, those with Autism

Spectrum Conditions have a particular desire to provide a "correct" answer, and may struggle with exploratory interview situations where the answer is not clear.

As proposed by Good and Robertson (2006), one way of reducing these limitations is to employ peer interviewing. Peer interviewing is when an individual conducts an interview with a member of his or her peer group, as described by Barnes et al (2000). This interview can take many forms from being highly structured to being completely unstructured; the important aspect is that both the interviewer and the interviewee are drawn from the same peer group. The level of structure is dependent on the skills of the peer group, as training is usually required for the interviewer. To date, there is no literature available in the use of this technique specifically with children or individuals with Autism Spectrum Conditions. The focus is on the use of peer interviewing for review, education or employment purposes (e.g. (Allen and Thrasher, 1998, Chew-Graham et al., 2002, Barnes et al., 2000)).

This style of interviewing may be useful in overcoming the difficulties of traditional interviewing when working with children. Peer interviewing may also allow researchers to explore interactions and levels of engagement shown by the target group, while giving insights and opinions not typically exhibited to adults. Allowing children to work directly within their peer group, and thus eliminating the need for adult involvement, may be more enjoyable and promote interaction, allowing an exploration of peer-to-peer interactions or of difficult or sensitive situations. When children with Autism Spectrum Conditions are considered, peer interviews allow this group to engage in structured interactions with familiar peers in a 'safe' environment.

Peer interviews were conducted in order to understand what children consider to be sharing behaviours, and how children define success in sharing. This study may be considered as a pilot study to assess the methodology of pilot interviewing with the typically developing

population before children with Autism Spectrum Conditions can conduct peer interviews. The methodology is considered and adaptations are proposed for the expansion of the participant group.

Participants

Peer interviewing was conducted with typically developing children (n=31, aged 7-8 years), recruited from a local mainstream primary school. All children were members of one classroom. The class teacher (Matthew) was involved in an advisory capacity.

Materials

The materials required for this study are shown in figure 11. These materials comprise one interview pack. A question sheet and instruction sheet were prepared in advance (see Appendix C) and were supplied along with a simple to use (FlipCam) camcorder. A PC running Microsoft Word, post-its and pens were needed for analysis.

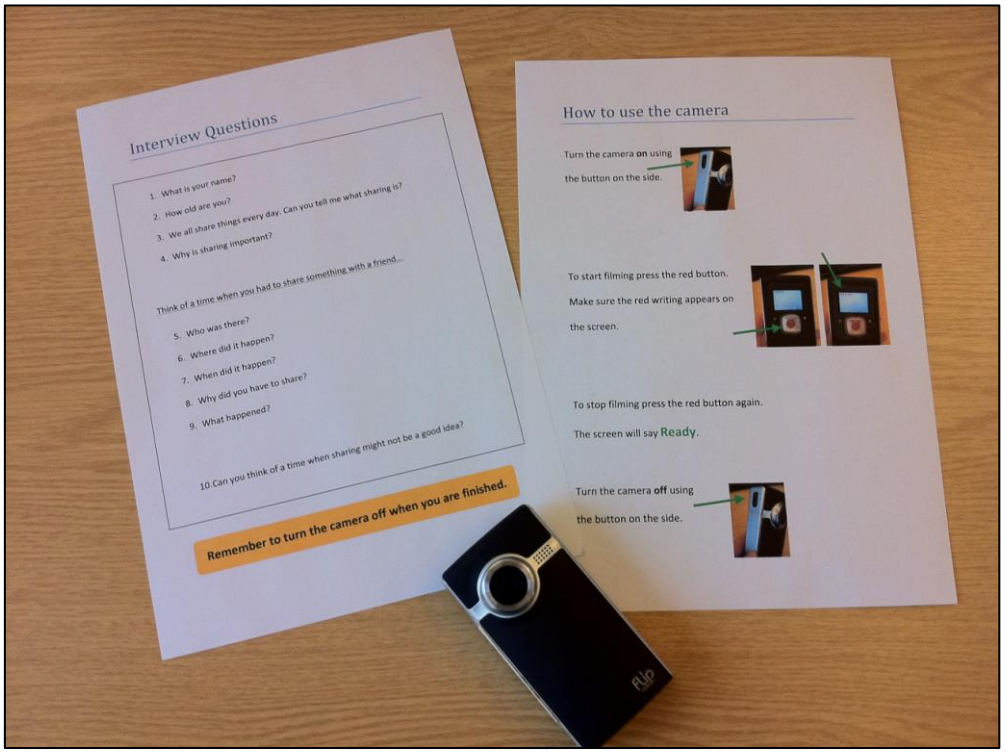


Figure 11: Peer interview classroom pack

Procedure

In the first instance, the researcher visited the school and discussed the activity with the classroom teacher. The immediate goal of this visit was to determine the literacy levels and abilities of the children in order to ensure that the materials were comprehensible by the participants. Interview sheets (appendix C) were then created. As recommended by Mazzone et al (2010), the classroom teacher confirmed these as being developmentally appropriate, the questions being structured in a similar way to those being considered within the wider curriculum. Once verified, the question sheets were laminated and formed into interview packs as shown in figure 11).

The researcher then visited the school to introduce the activity to the participants as part of an ICT lesson. The interview process was explained and a demonstration given of how to

operate the camera. The participants then began to conduct interviews with peers during free time in the classroom. After one week, the researcher returned to the school to debrief the participants and collect the materials. During the debrief session participants were thanked for their involvement.

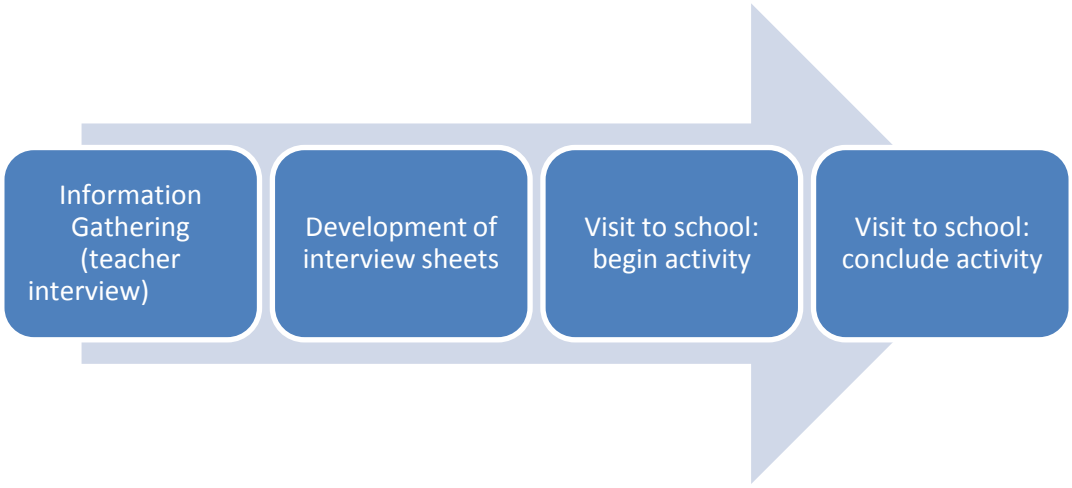


Figure 12: Peer interview process

To analyse the results, the researcher transcribed each participant interview. Following this, a grounded theory methodology was utilised (Glaser and Strauss, 1997) to extract themes from the transcripts. The transcript for each participant was looked at in turn. The key points of each response were identified and written on a Post-It note. Following this, similar codes were collated to form concepts. This grouping continued with similar concepts being gathered together to form categories.

Results

In order to analyse the peer interviews and determine the definition of sharing as understood by typically developing participants, the videos were first transcribed using a Microsoft Word template. From these transcripts, verbs were highlighted. Each one was written on a

post-it note and placed on a wall. Similar verbs were iteratively gathered to form groups of similar actions.

The analysis indicated that the participants collectively identified the following four categories of sharing which form the basis of an understanding of sharing as shown by the participants:

1. **Division of Objects**

   "Sharing things to make it even"

This is concerned with sharing objects such as toys between two people. Participants often referred to this in the context of classroom activities where there were more objects, such as pens, than there were children. The ideas of fairness and equality were prominent.

2. **Turn Taking**

   "When someone has something … they give it to the other person for a turn"

Participants expressed this category of sharing in relation to group activities where there was a limited number of toys, such as in the playground (fewer toys than children). Again, this was focussed on the idea of equality, ensuring that nobody is left without.

3. **Borrowing and Lending**

   "Letting someone borrow your toys"

This was focussed around ownership with participants expressing the importance of preference and friendship. For example, participants spoke of sharing their favourite toys or foods with friends.

4. Shared Ownership

"When two people play with the same toy together"

In this case, the participants expressed the need for co-operation and fairness to ensure that one individual did not take overall control of a shared object, such as during classroom games. This category of sharing was closely related to turn taking.

This direct involvement of children appears to have potential in opening their contributions to being unguarded, honest and naturalistic. Compared to classroom behaviour, the videos appear to show the children being more relaxed and less concerned with the activity being a 'classroom task', than an enjoyable game.

6.3.4. Discussion group with children with Autism Spectrum Conditions

Alongside the work being conducted with the typically developing participant group, discussions were conducted with children with Autism Spectrum Conditions. This was necessary to gain a balanced insight into the understanding of sharing in both participant groups. Specifically, this study aims to identify aspects of sharing as understood by children with Autism Spectrum Conditions.

Participants

Discussions were conducted with children with Autism Spectrum Conditions (n=3, aged 6-7 years), who were considered by teachers to be high functioning. Participants were recruited

from a local mainstream primary school with provisions for Additional Support Needs (ASN) including Autism Spectrum Conditions. All children were members of one class.

Materials

An example social story that focussed on sharing, using the researcher as the subject, was used in the study. The story described the act of sharing sweets with friends. Also, a book, 'The Rainbow Fish' (Pfister, 1996) was used. This book describes a fish that finds friendship and happiness when he learns to share with others.

Procedure

Discussions were conducted over two weeks in a small room on school premises with minimal potential for distraction. The researcher followed procedures routinely used by educational professionals to begin and end sessions, using the chart in Figure 6. The sessions were not recorded since not all participants had given consent for this. After each session, the researcher collated written narrative notes based on observations made during the sessions.

During the first session, the researcher read the book to the participants and began an informal discussion around the issue of sharing explored in the book. One week later, the researcher returned to the school and talked through the social story. Again, an informal discussion ensued whereby the participants were encouraged to think of situations where they have shared objects with their friends or family.

Results

The discussion group participants identified sharing as “being nice” and “taking turns”. This reflects the teachings of practitioners but is at odds with the results of earlier exploratory studies.

The involvement of children appears limited, but there is value in their repetition of classroom teachings. This repetition shows that the children have learned the principles of the skills, even if they did not display them in reality, as indicated in the exploratory studies.

6.3.5. **What objects? Design workshop**

Drawings are often used to gather participant’s views of computer technology (Denham, 1993) and to evaluate interfaces (e.g. (Xu et al., 2009, Plimmer and Apperley, 2004)). Furthermore, drawings are often a common component of a successful design process. This can include low fidelity prototypes such as interface designs (Plimmer and Apperley, 2004) and storyboarding (Walsh et al., 2010).

Specifically, Millen et al (Millen et al., 2010a, Millen et al., 2011) have successfully utilised drawings in the design of software systems for children with Autism Spectrum Conditions. Children with Autism Spectrum Conditions have been involved in the design work along with their typically developing peers. Adaptations have been made to accommodate the difficulties experienced in Autism Spectrum Conditions, such as the need for structure and a lack of imagination.

The use of drawings as a design development strategy has many advantages. They are fun and attractive activities, particularly for children. The tangible nature of drawing attracts enthusiasm, while it is portable with low costs. Children are familiar with the concept of

drawing activities within an educational environment and so this may fit into an established schedule for children with Autism Spectrum Conditions. Furthermore, children with Autism Spectrum Conditions may be unable to write proficiently or may feel unsure or be unable to express themselves verbally. In these cases, drawings can be a very useful tool to elicit information. The process of drawing can be very quick and efficient in obtaining accurate information as no training or practice is required to sketch ideas on paper (MacPhail and Kinchin, 2004).

Design workshops were conducted to explore the types of objects that may be present in the sharing tool. The identification of design themes can ensure that children can relate to objects on the screen, thus promoting potential engagement with the sharing tool. The possible interactions of the user with the tool were also considered.

These workshops were similar to those conducted as part of the Echoes project, outlined by Frauenberger et al (2011). The workshops conducted by Frauenberger as part of the Echoes project were focussed on not only the objects in the environment, but the potential for children to engage with these objects through the technology. However, these workshops have focussed solely on the possible objects that may be present in the technology environment in order to consider ways of improving users' initial engagement with the system.

Participants

Initial design workshops were conducted with typically developing children (n=27, 13 male, 14 female, aged 7-8 years), recruited from a local mainstream primary school. All children were members of one class and the class teacher was involved in an advisory capacity.

These children were the same children who had participated in peer interviewing as part of the ‘understanding sharing’ phase of the design development.

Further workshops were conducted with children with Autism Spectrum Conditions (n=5, 4 male, 1 female, aged 7-8 years). Participants were recruited from a local mainstream primary school with provisions for additional support needs (ASN) including Autism Spectrum Conditions.

Materials

A worksheet was created based on the work conducted by Frauenberger et al (2011). This was a background image of a garden (see figure 13), considered to be a familiar location for children with Autism Spectrum Conditions, which would reduce social anxiety. The worksheet shows the garden image along with instructions to add objects to the garden in order to make it a “fun place to play”. The use of a background image provides structure for the activity, allowing participants to construct a scope for the activity as recommended by Millen et al (Millen et al., 2010a, Millen et al., 2011).

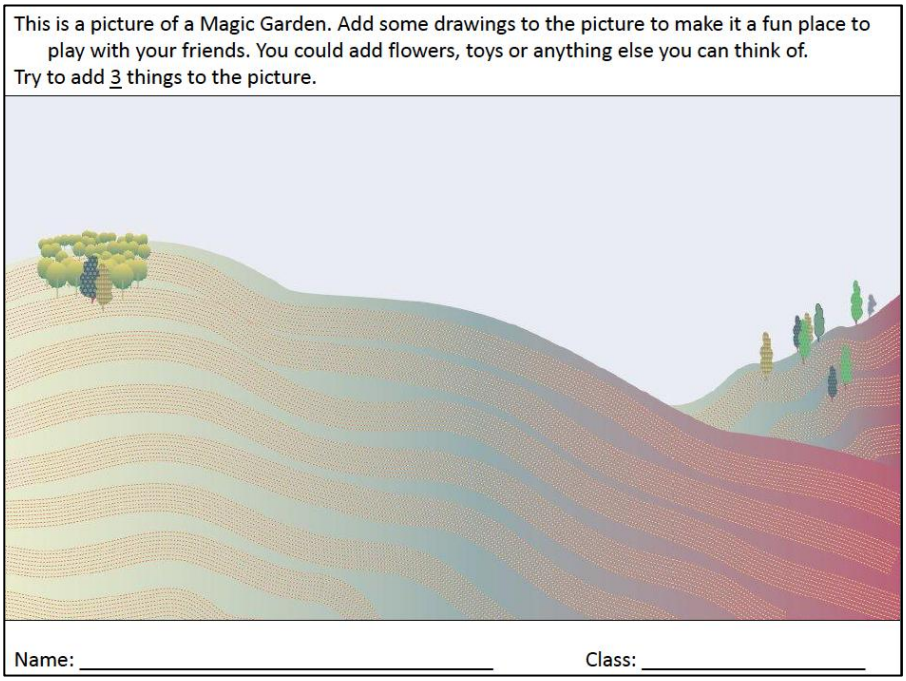


Figure 13: Design workshop worksheet

Craft materials were provided (see figure 14) including colouring pens, pencils, glue, scissors, pipe cleaners, tactile pompoms, post-it notes and coloured cardboard in various shapes.

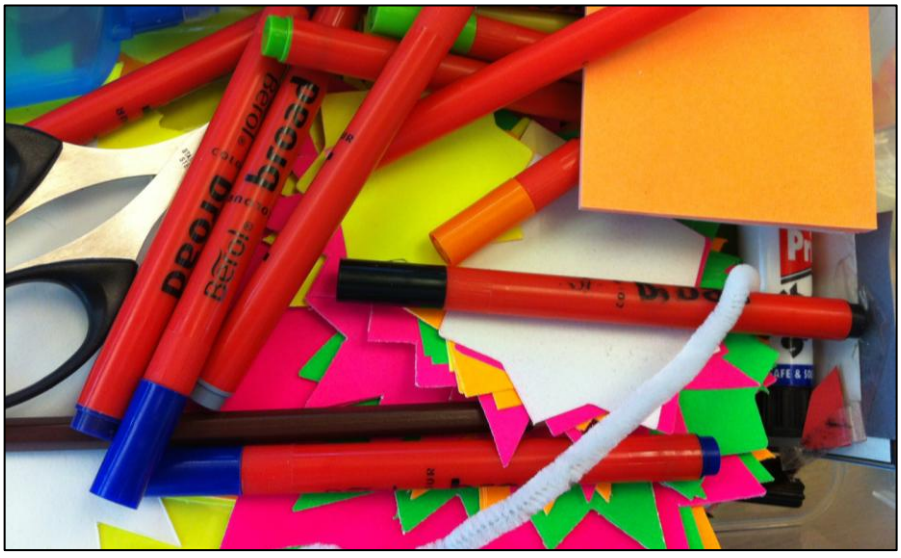


Figure 14: Craft materials for the What Objects? design workshop

Procedure

For the typically developing group of participants, sessions occurred in the classroom, for a period of one hour. The concept of a "Magic Garden" was explained to the participants: *"The Magic Garden is an imaginary garden where you can explore to find new things. In the garden anything can happen. It is a fun place to play".* Discussion around this concept was kept to a minimum in order to avoid undue influence by the researcher. The participants were invited to help the researcher to design a Magic Garden and were presented with the worksheet containing the background image. It was stressed that there was no wrong answer and that the participants should be as imaginative as they could or would like to be.

The session for the participants with Autism Spectrum Conditions lasted only 45 minutes. Furthermore, there was a "settling in" period to aid the transition to this activity where the task was described to the participants in a small room, separate from the main classroom. This minimised any possible distractions and assisted the participants to become focussed on the task. The researcher also took part in the drawing activity. By completing a drawing alongside the participants, the researcher provided reassurance that the participants were completing the task appropriately. Verbal encouragement and reassurance were also provided. A reduced selection of craft materials was available for use, comprising only colouring pens and pencils. This was in response to teacher advice on issues of sensory overstimulation as well as reducing the number of choices that the child had to make. As a result, this minimised the potential for anxiety.

Results

The drawings produced by participants were analysed using grounded theory methodologies. Each item drawn was written on a Post-it note and similar items were gathered together.

Following this, four themes were identified: (1) Space, (2) Fantasy, (3) Animals, and (4) Typical Garden. Within each theme a number of objects were identified that may be located within the sharing tool, such as spacecraft for the ‘space’ theme or unicorns for the ‘fantasy’ theme.

In addition, there was a clear difference in the types of objects drawn across genders by typically developing participants. For example, boys tended to focus on aliens and spacecraft, while the girls tended to focus on animals, fantasy and nature. This was not obvious in participants with Autism Spectrum Conditions, who tended to draw images that were reflective of reality and recent experiences.

During the session, the participants were engaged in the task, but often sought reassurance from the researcher and frequently competed for attention to show their work.

6.3.6. **Echoes summative evaluation**

An action research model was employed for the evaluation of the Echoes project. This involved developing a close relationship with staff at a school for children with severe physical and/or intellectual disabilities. By integrating the research team into the classroom setting, it was possible to utilise the expertise of staff to support the research team in working with the participants.

The evaluation of the Echoes system has focused around the SCERTS model (Prizant et al., 2006), where short video clips of the children are recorded in a number of contexts: namely the classroom, structured task-based activities and using the Echoes system. The potential for successful interactions is varied, due to the heterogeneity of Autism Spectrum Conditions (Geschwind and Levitt, 2007), and is assessed individually for each child.

Examples of success for a particular child may include the generalisation of skills learned into another environment (often difficult to accomplish in Autism Spectrum Conditions (Scattone, 2007)), improvement of skills during use of the system or even interacting with the system at all.

In addition to the video assessments, the Echoes system is evaluated through the observations of practitioners (such as teachers and classroom assistants) alongside interviews with those involved in the deployment of the system within the school environment.

While this research is not a direct part of this PhD research, the lessons learned from participating in the evaluation have had direct implications on the design of the sharing tool.

Participants

Six children (5 male and 1 female) with Autism Spectrum Conditions, chronologically aged between 12 years 5 months to 13 years 9 months, were recruited to participate in the study. The participants had a receptive vocabulary age of 3 years 2 months to 5 years and 11 months as determined by use of the British Picture Vocabulary Scale (Dunn et al., 2009), and associated learning disabilities. Individual details are noted in table 9. The probability of a diagnosis of an Autism Spectrum Condition was confirmed by having parents or primary caregiver complete a Social Communication Questionnaire (SCQ) (Rutter et al., 2003a). A score of fifteen or greater indicates that further evaluation should be conducted for a diagnosis of an Autism Spectrum Disorder.

All participants are educated in a specialised classroom for children with Autism Spectrum Conditions in a local special school. A range of augmentative communication techniques is

employed including signing and the use of symbols. The use of these is dependent upon the individual participant's needs. See Section 4.2.1 for a full description of each participant.

Table 9: Participants in Echoes Summative Evaluation

Participant	**Age (years)**	**Receptive Vocabulary age (years)**	**SCQ score**
Alison	12:05	5:11	26
Robert	12:07	*Not available*	28
Gordon	12:09	*Not available*	18
Stuart	13:09	4:02	17
Chris	12:08	*Not completed*	26*/35**
Craig	13:04	3:02	32

* Completion of SCQ questionnaire by mother.

** Completion of SCQ questionnaire by father.

Materials

The Echoes software ran on a desktop computer running the Windows 7 operating system. The participant interacted with the system using a 42" multi-touch screen. The researcher controlled the system and settings using a standard desktop monitor, mouse and keyboard (see figure 15).

Figure 15: Echoes equipment

Some participants were given prompt strips containing useful symbols relevant to the session (see figure 16 for an example). These participants were encouraged to use the prompt strip to request assistance, a new scenario or to finish. In addition, the participants were presented with the strips at the beginning of the session to show the within-task[5] schedule for interacting with Echoes.

Figure 16: Example prompt strip used by children to request different scenarios

[5] The sub parts of a whole task.

Procedure

An empirical research approach was employed throughout the action research study. Participants attended 10 sessions (2 per week for 5 weeks) of approximately 20 minutes. The participants were accompanied by a Support for Learning Assistant (SLA) who provided support and facilitation where required. This included physical assistance using the screen or providing prompts and encouragement as required by individual children.

To begin each session, the participant would start the system by touching their name, which was displayed on the screen. The first scenario was "bubbles" where the participant could pop and merge bubbles, with larger bubbles making a deeper and louder sound than smaller bubbles. This served to familiarise the child with the touch screen and afford them control over the system. Participants then worked through a number of scenarios focusing on joint attention and turn-taking skills. Each child progressed through these scenarios at a rate appropriate for their abilities, with the eventual introduction of the 3D character, 'Andy'.

Participants were encouraged to engage with Echoes independently but were also encouraged to ask for help if required. Where the participant displayed signs of distraction, they were re-directed to the Echoes system by a member of the research team.

The sessions were recorded in a number of ways. Firstly, they were video recorded so that the videos could be coded using a coding structure adapted from the SCERTS model (Prizant et al., 2006). Also, after each session, the researcher completed a session diary entry, allowing each participant's progress to be monitored throughout the study.

Results

The Echoes summative evaluation highlighted the potential of an exploratory computer system to improve social skills in children with moderate to severe Autism Spectrum Conditions. The ability of the system to reinforce teaching methods used in reality, such as signing systems and the frequent use of the child's name, was a particular success. This was noted by practitioners involved in the study, along with the benefits of the structure within the system. The bubble scenarios had a dual purpose within the system, providing motivation for the participants to complete tasks, while being an option for emotional regulation. The importance of emotional stability was reinforced through the introduction of the timetabling and timing strategies, such that the participant was aware of a clear end-point for each task or scenario.

Further, the significance of embellishing the emotional state of characters and responses was noted. Practitioners indicated that children with Autism Spectrum Conditions would tune into changes in emotion when these were exaggerated, which was reinforced by the actions of the participants during sessions. The multi-modality of the interaction was popular, with different participants focussing on their preferred modality.

6.4 Implications for design

6.4.1. **Understanding sharing**

Sharing was previously identified as an area for further research. In order to engage in a participatory and user-centred methodology, the context of the research must be considered. In particular, the subject area was considered with respect to stakeholders' understanding of

sharing and how it may be considered in a social setting. Peer interviews have given rise to task requirements, which have been verified by interviews with practitioners.

The importance of sharing was highlighted during practitioner interviews. Sharing is considered to be the basis of peer-to-peer interaction and was noted as a frequent area of difficulty for children with Autism Spectrum Conditions. Practitioners noted that they spent a lot of time focussing on skills such as turn taking and sharing objects such as pencils, scissors etc. in the classroom. However, despite the best efforts of staff, there was a lack of generalisation to other areas, since the skill was being taught in specific circumstances. It was also highlighted that the child had to be aware of the skill itself and its potential applications in order to generalise it. Nevertheless, it is often the case that children with Autism Spectrum Conditions are not aware of the elements of a given social skill and so cannot form a schema for transferring that skill to a new situation.

With the importance of sharing clear, the definition of sharing as understood by children was deliberated. The categories derived from analysis of peer interviews are shown in figure 17. These categories form the basis of an understanding of sharing as shown by the participants.

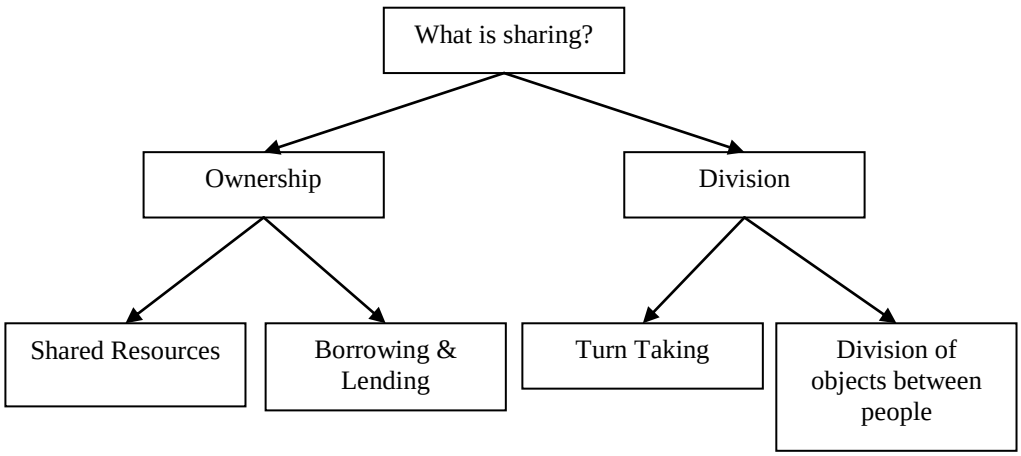


Figure 17: Sharing categories identified

The above results were discussed with the classroom teacher, a Speech and Language Therapist and a teacher who specialised in Autism Spectrum Conditions. These professionals verified these categories as valid components of sharing, based on their own personal experiences. In particular, the "division of objects" and "turn taking" categories were discussed as, based on their educational experience, these two skills are very closely related. It was proposed by this group that the "division of objects" and "turn taking" should be the initial skills considered when learning about sharing.

This study of peer interviewing has allowed for the gathering of rich qualitative data, which has been instrumental in constraining the scope of the project. This scope comprises the categories of sharing behaviours as identified by typically developing children and verified by professionals. Software design should be focussed on aspects of sharing that are seen by parents and teachers as being problematic for children with Autism Spectrum Conditions. These results describe the typical understanding of sharing and so difficulties in Autism Spectrum Conditions can be identified in relation to these. Based on interviews with practitioners and exploratory observations (see Chapter Five), the greatest difficulties are concerned with "turn-taking" and the "division of objects".

Of these categories, children with Autism Spectrum Conditions unanimously identified turn taking as the main definition of sharing. When pressed for examples, the children suggested taking turns with toys during play times or sharing sweets with a friend. They indicated that sharing was *"being friendly"* and that sharing sweets was *"being nice"*. Discussions did not indicate that the children had any understanding of the act of sharing in novel contexts (such as the Rainbow Fish sharing his scales) and did not indicate any specific understanding behind the rationale for sharing behaviours. In particular, the participants clearly understood

the practical and physical elements of sharing and so this was reflected in the interaction design.

6.4.2. **Designing the interface**

The ‘look-and-feel’ of the interface is the first impression that the children who will use the system will have. While children with Autism Spectrum Conditions are motivated by technology (Moore, 1998), their initial impressions, like the typically developing population, will go a long way towards holding their attention and a suitable design can generate motivation and increase engagement. In order to design the ‘look-and-feel’ of the system, stakeholders were involved in a number of activities to develop the interface design. These activities were the SAGE workshop, the What Objects? Design Workshop, interviews with practitioners and the Echoes summative evaluations. Figure 18 shows the influence of each study on the results.

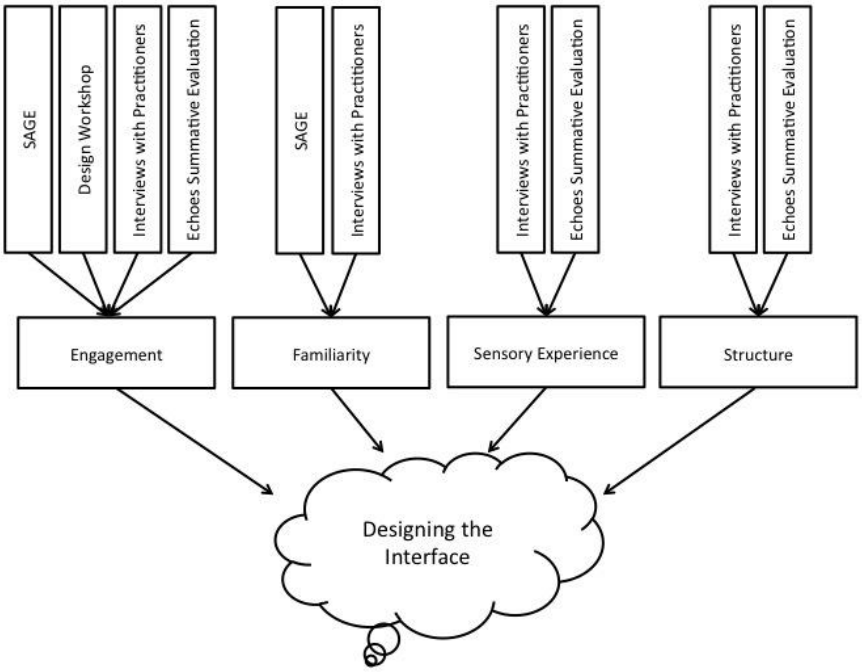


Figure 18: The studies informing the interface

Engagement through customisation and motivation

Across all studies, the main issue raised was that of engagement with the sharing tool, and how this may be increased by providing motivation and customising the tool. It was noted that the children *"must want to use it… this is triggered by the design"* (SAGE participant). Customisation, i.e. the adaptation of an intervention to match the needs of an individual (Whalen et al., 2009), is widely considered an effective way to promote engagement (Mazzone et al., 2010). This is an area to which practitioners devote a great deal of time when devising therapeutic interventions for children with Autism Spectrum Conditions.

The What Objects? Design Workshop specifically focussed on exploring the objects that might be present and interacted with in the sharing tool, and the implications for customisation. Following the analysis of objects drawn by the participants of this workshop,

four themes were identified: (1) Space, (2) Fantasy, (3) Animals, and (4) Typical Garden. These may become design themes, which the children can select in order that they might customise the system how they wish. Within each theme a number of objects were identified that may be located within the sharing tool, such as spacecraft for the ‘space’ theme or unicorns for the ‘fantasy’ theme.

There was a clear difference in the types of objects drawn across genders, which was typical of the interests of typically developing children. For example, boys tended to focus on aliens and spacecraft, while the girls tended to focus on animals, fantasy and nature. These gender differences should be given due consideration, since the ratio of boys to girls with Autism Spectrum Conditions has been quantified as 4:1 (Raznahan and Bolton, 2008).

These gender differences were not apparent in the drawings by children with Autism Spectrum Conditions, although the participant numbers were very small (n=5) with only one female participant in this group. The drawings produced in this group were highly focussed on previous experiences and included objects such as swings and slides. Other objects were also related to typical play park environments, including an ice-cream van and a shop selling confectionary.

Further to this, motivation for engagement was discussed with practitioners, both through interviews and participation in the SAGE workshop. This motivation might incorporate special interests of an individual child, perhaps by allowing the adult to upload an image that will encourage the child to participate. However, there was some debate among participants, particularly during the SAGE workshop about just how helpful this level of customisation would be. It was proposed that having objects on the screen that were related to the child’s own special interest may encourage initial engagement, but it is possible that the child could lose focus on the purpose of a task as they are distracted by the objects. Indeed, many

children with Autism Spectrum Conditions perform repetitive behaviours in relation to their objects of special interest, such as spinning the wheels on a car.

Motivation played a key role in the Echoes summative evaluations. The adult in control of the Echoes system could select a scenario to fit the needs and skills of an individual child. A large component of this decision was based on what would motivate the child. As a result, the bubble scenario was, after an initial exposure, reserved as a motivator. In effect, the adult created a reward structure to motivate the child whenever this was required.

The absence of customisation was also discussed with practitioners during interviews and the SAGE workshop. They indicated that whenever customisation is not possible, the child should be presented with generic items such as those readily available in the classroom as these will be familiar to them. Importantly, where possible, objects the children particularly dislike should be avoided, as they will quickly become disengaged, despite the likely attraction of the technology.

Familiarity

The use of familiar objects, at least at the beginning of the session, encourages engagement with the system. Practitioners indicated that using familiar objects would reduce possible anxiety that may arise as a result of the unknown object, while the use of generic objects commonly found in the classroom would reduce the risk of undue attention being focussed on the objects.

The use of a garden background was considered by practitioners to be a suitable choice of location, as the vast majority of children will have experienced a garden at some point in their lives and so would be familiar with the location. Considering the idea of customisation,

this (as the most generic) should be the default location with the child able to select a different location if they wished. In the final sharing tool software, only the garden scene is implemented, with the further customisation using themes comprising a future research direction.

Sensory experiences

During the Echoes evaluation, it was clear that some participants actively sought sensory experiences. For example, Chris would often drag bubbles together in order to create a louder sound. Similarly, Robert would press his face close to the screen and watch as a bubble passed by. This sensory seeking behaviour was seen in some form in most participants, but was different in each one.

In addition, practitioners confirmed that children with Autism Spectrum Conditions often seek sensory experiences, a behaviour that can be exploited by practitioners to provide motivation to engage with therapy or learning. Some children may be particularly sensitive to one or more of the senses. The interface must present opportunities for different modalities, such as sight and sound in order to encourage such children to engage with the system. Bright colours and colour clashes should be avoided where possible, at least at the introduction to a task, as these can be very distracting for children with Autism Spectrum Conditions.

Structure

It is important that the structure of the activities can be clearly seen in the interface. Recommendations from practitioners included the use of timers and timetables to show

instances in time when the interface will change. These are currently used in the classroom (in the paper form) to depict within-task schedules and have been of great benefit during the Echoes summative evaluation (see figure 16).

Specifically, it is useful for the timer to be included during a bubble-popping activity, since this activity has no clear ending and the use of a timer would facilitate this. This feature was not implemented in the Echoes environment, but was explicitly requested by the practitioners involved in that research. The ending of the bubbles activity can also be facilitated by a countdown of the number of bubbles popped; a strategy often verbally implemented by the practitioners involved in the evaluation.

The use of paper-based within-task schedules was particularly beneficial during the Echoes summative evaluations, but was subject to difficulties, such as becoming lost or damaged. Practitioners noted during interviews that it would be extremely useful if the schedules were available within the sharing tool in order to alleviate any anxiety experienced by children with Autism Spectrum Conditions.

6.4.3. **Designing the interaction**

It is important that the interaction of children with Autism Spectrum Conditions with computer technology is well developed through the inclusion of practitioners who can articulate the rationale for decisions made. Children with Autism Spectrum Conditions have an affinity with technology (Moore, 1998), which has driven many research projects to date (e.g. (Rajendran, 2000, Swettenham, 1996)). The design of any interaction that children with Autism Spectrum Conditions may have with technology must transcend this affinity in order to allow the child to focus on the learning goals of the system. It is important that the user is

able to interact with the system in a manner that does not induce anxiety, but can facilitate the exploration and implementation of social skills. Studies that addressed the design of the interaction (shown in figure 19) were the SAGE workshop, interviews with practitioners and the Echoes summative evaluations.

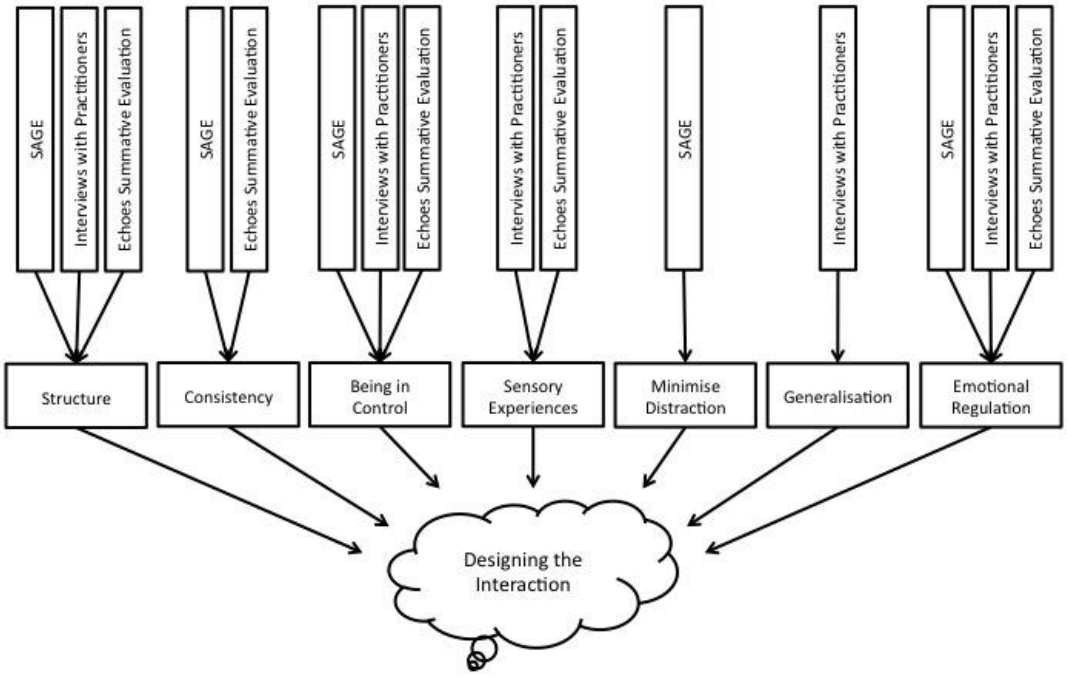


Figure 19: The studies informing the interaction

Structure

The need for a structured interaction was apparent from all studies. Practitioners consistently highlighted the rigidity of thought and behaviour seen in Autism Spectrum Conditions, while during the Echoes evaluations, paper-based schedules were used to great effect. This has been translated into design requirements.

For example, there should be no sudden changes, such as moving from one screen to the next. When the task is changing, the children should be notified. This may be accomplished through the use of timers to show how long the present activity will last for and provide a clear end point for activities. However, during sharing activities there should be no timer. Practitioners indicated during interviews that this is likely to induce anxiety and does not take account of the fact that different children will explore and learn the associated skills at different rates. In this case, an alternative end point should be considered to ensure that the child can complete the activity. It is important for pedagogical reasons that the child can achieve success and move onto the next activity in order to stay motivated for learning.

The use of a timetable or schedule is also important with respect to a structured interaction. The timetable should indicate the current position in the within-task schedule. This will show a clear finish point for interaction with the sharing tool.

Consistency

The purpose of the on-screen character should be to assist the child in exploring sharing skills and achieving the learning goal in each scene. As such, any character verbalisations should be related to this, with the character behaving in a consistent manner in all scenes. This was highlighted as being of vital importance during the SAGE workshop. In particular, the system should respond to the children's actions in a consistent and predictable manner. This consistency is key to reducing anxiety caused by unexpected changes.

In addition to the consistent behaviours of the characters, the wider reliability and consistency of the system is paramount. Anything unexpected, such as the system crashing,

will disrupt the interaction to the detriment of possible engagement and emotional regulation.

Being in control

It was discussed during the SAGE workshop that children with Autism Spectrum Conditions often have limited control over interactions and the environment in the real world, so it was important that any system for this user group allows them to exert some control over their environment. This control may be included, such that the characters should interact with the child at a pace that allows the individual child adequate time to process the information being presented.

Practitioners noted that children with Autism Spectrum Conditions recognise emotions and behavioural intentions much more clearly when they are embellished and overstated. The concept of praise was also explored within this area, with many practitioners indicating that children they worked with were particularly responsive to exaggerated praise. This was clearly seen during the Echoes summative evaluations. During one session, the researcher and school staff member applauded a child's success as a means of emphasising that he had succeeded in completing the task, which he had found difficult. He then initiated the repeat of this success by counting down from 10 to 1 and looking towards the researcher, gesturing applause. He repeated these actions on a number of occasions, often seeking praise from researchers and school staff during different tasks. Practitioners have suggested, based on this example and their own knowledge, that giving children with Autism Spectrum Conditions an experience of joy through their own successes is important. This joy may take different forms depending on the child, but it is clear that the opportunity is presented here for the child to take control of the praise and enjoyment of the interaction. Of the

practitioners involved in interviews, Yasmin and Sue were particularly enthusiastic with regards to inclusion of repeatable praise that can be controlled by the user.

Sensory experiences

The child should be able to interact with the system using different modalities. The use of multi-modal interaction can be useful since different children will focus on different modalities and seek these where possible. Practitioners suggested two options: either customising the sharing tool to focus on the preferred modality, or providing a number of different modalities to engage a wide spectrum of children; for example, having success shown by displaying both visuals and sound. During the Echoes evaluations, a scene, which indicated success by using various multi-modal animations such as fireworks, was very popular with the children since they could focus on their preferred modality. This was a notably successful aspect of the Echoes project with some children seeking sensory experiences such as sound by allowing bubbles to become larger before popping them in order to elicit a louder and deeper sound. Thus the use of an exploration of different modalities as a reward structure can be very beneficial.

Minimise distraction

The character is likely to be the most distracting aspect of the interaction, since there is potential for the child to react in many ways. This may be in response to the characters appearance, voice tone or gestures. Where the character makes gestures, these should be simple and clear, with one SAGE participant commenting, *"less is more"*. This concept was further reinforced in discussions with an expert in animation and inclusive design.

Distractions should also be minimised within the wider environment where possible, to ensure that the child experiences minimal distraction while working with the sharing tool. Such an environment should be quiet and without physical distractors such as favourite objects. This is a common strategy to promote task engagement and is also considered to be important within the SCERTS framework (Prizant et al., 2008a).

Design for generalisation

Practitioner interviews corroborated earlier exploratory studies (see Chapter Five) and observations that considerable time and effort were exerted in promoting generalisation of knowledge and skills, a known difficulty in Autism Spectrum Conditions (Anderson et al., 2009). The two areas discussed, particularly with therapists during interview sessions, were the need for repetition and a match to reality, in order to facilitate skills transfer.

Repetition was identified as a key to success, with the planning of interventions including provisions for repeating the task or performance of a skill. This may include repeating the task at one point in time, or returning to the task on numerous occasions in order to provide further opportunities for learning.

The consensus of the practitioners involved in interviews was that in order to promote the generalisation of social skills learned, the character should behave in a similar manner to the child's potential social partners in reality. This has also been identified in the literature as being a beneficial aspect of therapeutic interventions, with one study by Tan (2000) showing clearly that the participants were able to generalise social skills only to those situations that were similar to the computer-based tasks.

For example, phrases should match those used in the classroom, as these will be familiar to the children. Participants provided a number of set phrases commonly used in the classroom or therapy setting. These phrases, combined with data gathered during the exploratory studies (see Chapter Five), formed a phrase bank and will form the basis for communication by the character.

Emotional regulation

As a central aspect of SCERTS (Prizant et al., 2008a), emotional regulation is a crucial part of any interaction a child with an Autism Spectrum Condition may have. This is defined as *"supporting a child's ability to regulate emotional arousal"* (p.4) and has wide reaching implications. Children who are able to regulate their emotional arousal are more readily available for learning, which means that they can be socially engaged, process relevant information and actively participate in activities.

Practitioners across all studies raised this issue, specifically with relation to the engagement of the child in on-screen activities. It was noted that new or unfamiliar activities give rise to increased anxiety and an increased emotional response. Therefore, the child must be given opportunities to reflect on the learning experience, process the information and skills considered during the task and allow their anxiety and emotions to settle. Children with Autism Spectrum Conditions typically find emotional regulation to be difficult, thus the need to facilitate this is great.

During the Echoes evaluations, the bubble popping activity was central to the participants' emotional regulation. The bubble popping activity appeared to serve a dual purpose concerning emotional regulation: the participants who were typically highly aroused seemed

to calm their arousal by exploring the bubbles, while those who were typically under aroused appeared to be stimulated by the bubbles. School staff were of the opinion that the bubbles activity allowed the children the opportunity to create their own rules and that each child had, in effect, developed their own tasks within the scenario. For example, some children tried to create larger bubbles while some tried to pop as many as possible.

6.5 The participation of children with autism spectrum conditions

Children with Autism Spectrum Conditions have contributed to the initial design of the sharing tool through a number of activities. This contribution occurred at a number of locations throughout the development of the sharing tool. The children with Autism Spectrum Conditions were involved primarily as design informants.

Involvement in the design of the sharing tool began from its conception with a discussion group, along with the peer interviews conducted with typically developing peers, focussing on understanding the concept of sharing. The purpose of such involvement was to ensure that the sharing tool is focussed on a concept of sharing that is applicable in reality, such that any skills learned could subsequently be generalised to real-life situations.

For example, the aim of the discussion group was to determine the opinions and knowledge of children with Autism Spectrum Conditions in relation to sharing. However, results from the discussion had limited impact on the development of the sharing tool, since the discussion focussed heavily on the examples given. This has reinforced the lack of imagination reported in the literature and exhibited by those with Autism Spectrum Conditions (Wing, 2003), despite recommendations in the literature being to provide examples in order to stipulate a context for the research activity (Millen et al., 2010a).

Despite the participants being high functioning, they were unable to articulate examples outwith those given. In addition, some children showed anxiety related behaviours during the session, which may have impacted their ability to participate effectively. Where this discussion group is likely to cause anxiety in the participants, this user group should be observed in a variety of environments such as was conducted in the exploratory studies. This will allow opportunities for the researcher to observe multiple natural behaviours across locations.

Children with Autism Spectrum Conditions were also involved in the What Objects? Design Workshop. Some adaptations were made to the process compared to the workshop conducted with typically developing children, which may have encouraged their participation. This includes providing fewer craft materials in order to avoid sensory overstimulation and providing a structured and enclosed environment to minimise possible distractions. Overall, the children were, for the most part, able to participate in the activity. Engagement with the activity was high, and this has been attributed to the adaptations made. In fact, children with Autism Spectrum Conditions sought less encouragement and reassurance from researchers than their typically developing peers. Based on the consensus that children with Autism Spectrum Conditions seek to provide a "correct" answer (Frauenberger et al., 2012), this was surprising.

However, the creativity seen in the participants with Autism Spectrum Conditions was less obvious than their typically developing counterparts. The participants were again focussed on current and recent events and experiences, rather than exhibiting what is typically interpreted as creativity. While the participants were provided with a garden background, which served to scope the task and direct the participant towards a concept that they were familiar with, this may have been insufficient. Future work with this group should ensure

that the participants are given further direction and that this is not limited to physical scoping. Scaffolding for emotional support, while not sought during the session should be purposefully provided in order to elicit even more meaningful contributions.

One particular drawing was unintelligible, which provided opportunities to consider just how meaningful the involvement of this user group was and could be. It is possible that the child in question had completed the task asked, but was unable to convey their thoughts and opinions due to their limited verbal ability. Alternatively, it is possible that the child did not fully understand the task as the concept of using imaginative thought processes was simply too abstract for him to comprehend. Discussions with the classroom staff have indicated that the latter reasoning is most likely true.

With this is mind, it is important that the communication between the researcher and the participants is considered from the outset, particularly in relation to the specific individuals involved in the research. This customisation of communication style, although often time-consuming, is likely to bring out the best in participants by making the comfortable and at ease during the research process.

While the literature (e.g. (Prizant et al., 2006)) gives many examples of how best to communicate with children with Autism Spectrum Conditions, this was best experienced during the Echoes evaluations. For example, the need to impart only one piece of information at once and to allow time for this to be processed was crucial in assisting the participants to understand what was required of them. This was often reinforced by the use of paper-based within-task schedules (see figure 16). Other advice such as avoiding the use of metaphors and ensuring instructions are specific was also very useful.

There are also wider practical implications in involving children with Autism Spectrum Conditions in research. The most obvious of these was to be consistent, and often firm, in the interactions. It can often be difficult for children with Autism Spectrum Conditions to decide whether the researcher falls into the social categories of a friend or a teacher, and so it can be difficult for them to decide how to interact. By modelling appropriate interactions, the researcher can reduce any anxiety and assist in regulating any associated stress or emotional arousal. In addition, the timetabling of sessions can be difficult. The participants during the Echoes evaluations wished to be told at the end of each session when the next session would be. However, the subsequent session was sometimes not organised or might have clashed with other classroom events, which could have left the participants feeling worried or confused. It is important that a strategy for organising the practical implementation of the research is decided beforehand and agreed by all members of the research team (including school staff). This means that unified decisions and information is presented to the children.

In particular, researchers should also make every effort to ensure that the vocabulary used is the same as that typically used in the classroom. For example, if the classroom teacher refers to art and craft activities as “making things” then the researcher should use this terminology rather than “art and craft activity”. However, this may not always be possible since the vocabulary used for research can vary enormously. This, coupled with a change in timetable or the presence of unfamiliar researchers, may mean that participation in the activity is outwith the comfort zone of the participant. As such, explaining the task using multiple communication strategies is useful, even if additional augmentative communication strategies are not commonly used in the classroom. This can include the use of symbols or drawings, gestures or basic signing.

On the whole, children with Autism Spectrum Conditions have had some impact on the design of the sharing tool, but this impact has been limited due to difficulties centred on imagination and Theory of Mind. Adaptations to the methodologies for this user group have resulted in engagement with the tasks, but have been unable to foster the creative environment associated with typically developing peers. Their involvement thus far, however, is sufficient to provide confirmation of the literature concerned with creativity exhibited by children with Autism Spectrum Conditions. Some information has been gained about behavioural patterns and the experience of interacting with this user group has lent itself to much thought surrounding appropriate interactions and ensuring that the wider context of implementation is considered in the development of the sharing tool.

6.6 Requirements

A requirements document was created and updated throughout the design studies. This document was expanded throughout the research and can be found in Appendix A. The document was re-visited at regular intervals throughout the design and development of the sharing tool, being verified by study results and by practitioners involved in an advisory capacity.

The users of the system were specified to ensure that the development activities were targeted appropriately. The customisation of the system to accommodate a range of such users was deemed imperative, and so this was explored. The requirements gathered indicated that the system should consist of two types of activity: the sharing scenario and a bubbles activity. Within the sharing scenario, the appearance, actions and behaviours of an on-screen character were considered in order to promote engagement of users with the system. Overall, the design activities highlighted a need for a structured interaction that was regulated by the

system, while allowing the user an element of control. This control is focussed on allowing opportunities for emotional regulation, which is also reflected in the need for the system to present opportunities for the engagement of sensory experiences.

6.7 The participation of practitioners

Practitioners have contributed a breadth of experience to the development of the sharing tool. This contribution of experience and opinions has allowed the researcher to effectively harness the knowledge of this stakeholder group. The contribution has incorporated the development of both the interface and interaction of the sharing tool. In addition, practitioners have confirmed the understanding of sharing through a consideration of the context and practical application of the sharing tool. By including practitioners in the design process, the resultant sharing tool is considered to be more suitable, since the needs of the main user group (children with Autism Spectrum Conditions) are represented in the design.

In this research, the involvement of practitioners in the design of the sharing tool has been invaluable, both as experts in their own right and as proxy users representing children with Autism Spectrum Conditions. While the contribution of children with Autism Spectrum Conditions to the design is paramount in ensuring the development of a usable and functional system, the practitioners user group can complement this involvement. For example, where the children with Autism Spectrum Conditions may be unable to articulate their emotions, a practitioner may have an excellent knowledge of that child and can successfully infer their emotions through analysing their behaviour and interactions. Thus, where the children with Autism Spectrum Conditions may indirectly inform the design, the practitioners can ground this information in context and therefore ensure that the correct information is inferred in the design of the sharing tool.

Through their involvement, practitioners have the opportunity to network with their peers and other practitioners from different professional backgrounds. This has allowed them exposure to different views and approaches to therapy, education and interaction with children with Autism Spectrum Conditions, as well as access to current research themes and active research projects. In many cases, this exposure can be difficult to attain due to the demanding timetable and workload of practitioners.

Chapter 7. **Formative evaluation**

The development of the sharing tool has resulted from an interactive participatory design process in order to produce software that is both functional and usable. A design concept was developed as a result of the design work conducted during the research and the implementation of this is described in Chapter Eight. As a result of this design concept, a high-fidelity prototype system was developed and presented to stakeholders and usability experts for formative evaluation. The aims of this evaluation were to identify any issues in the interaction design or usability of the sharing tool and to relate these to the target user group of children with Autism Spectrum Conditions.

The development of the prototype was iterative throughout this period of evaluation and was concluded when the prototype fulfilled the specified requirements.

This chapter describes the formative evaluations conducted and the evolution of the sharing tool from the initial design prototypes developed in Chapter Six. Like the development of the design, the evolution of prototyping has been grounded in the input of the stakeholders throughout, both in the evaluation of prototypes and the subsequent development of these.

7.1 Focus group with usability professionals

7.1.1. **Participants**

Two usability professionals (Damien and Simon) were involved in the study. Both had five years of industry experience. This experience comprised interface evaluations and consultations on website accessibility and usability. Both participants had a MA Computing Science degree, attained in 2007, and worked together (as mid-level management) in the same IT Consultancy Company.

7.1.2. **Materials**

The high fidelity prototype (created based on the design developed from Chapter Six) was used in the sessions. Paper and pens were provided. An HDR-CX155 camcorder was used to record the sessions.

7.1.3. **Procedure**

A focus group was conducted with the participants. The aim was to explore and evaluate the high fidelity prototype, with respect to usability. An overview of the sharing tool design was presented to the participants, before they were given the opportunity to explore the prototype on a 30" touch screen monitor, conducting a heuristic evaluation. Participants were encouraged to consider their own usability knowledge and were provided with descriptions of Jacob Neilson's 10 heuristics to consider. Participants were asked to keep a written record of their heuristic evaluation in any way they wished.

After the participants had conducted their own heuristic evaluations, the researcher discussed the outcomes with both participants. Participants were encouraged to raise issues for discussion, based on their notes made during the heuristic evaluation period and to collaboratively propose solutions to any usability issues identified.

7.2 Interviews with practitioners

7.2.1. **Participants**

Practitioners with a variety of backgrounds were interviewed (see table 6), some of whom were involved in the design phase (n=2) and some of whom were exposed to the sharing tool for the first time at this point (n=3). These participants[6] were:

- Amy *
- Natalie *
- Samantha
- Ruby *
- Yasmin

Those previously involved in the research were teachers with a wealth of experience in education for Autism Spectrum Conditions. Of the new participants, one was a teacher in mainstream education and two were currently involved in teaching children with special needs, including Autism Spectrum Conditions. All had experience in supporting school pupils with additional support needs in educational settings. Full participant details can be found in Section 4.3.

7.2.2. **Materials**

The high fidelity prototype (created based on the design concepts developed in Chapter Six) was used in the sessions. For some sessions, low fidelity prototypes (storyboards) or mid fidelity prototypes (screenshots) were used, along with post-it notes, coloured pens and

[6] * denotes that the participant has not previously been involved in the research.

blank paper. For all sessions, an audio recording or video recording device was used to record the sessions.

7.2.3. **Procedure**

A first interview was conducted with all participants with the aim being to explore and evaluate the high fidelity prototype. An overview of the sharing tool design was presented to the participants, before they were given the opportunity to explore the prototype on a touch screen device. Participants were encouraged to consider children they regularly work with when using the sharing tool. Based on this, the participants identified issues within the prototype that may cause difficulties for these children. The researcher stimulated this exploration, using their own knowledge of heuristic evaluation to guide the participants through the system. Upon identification of these issues, both the participants and researchers undertook collaborative rapid prototyping methodologies to produce solutions. For example, participants were encouraged to alter sample paper prototypes provided by the researcher using the materials provided in order to provide design solutions. This included marking up designs using post-its or providing alternative representations.

Once these design solutions had been identified, they were incorporated into the high fidelity prototype. A second interview with each participant focussed on the final prototype and ensured that all concerns previously raised by participants had been addressed. The participants were asked to perform a cognitive walkthrough, both from their point of view and from that of a child (or persona) with an Autism Spectrum Condition. The use of participants as proxy users for children with Autism Spectrum Conditions allowed the researcher an understanding of the behaviour of potential end users, with a rationale for that behaviour provided.

7.3 Pilot of sharing tool high-fidelity prototype

7.3.1. Participants

A total of six children participated in the study to evaluate the prototype. Three typically developing siblings were recruited from an after-school club. A further three children with Autism Spectrum Conditions also participated in this study. Of these participants, one of the children with Autism Spectrum Conditions (Alison) had previously been exposed to the Echoes system during the Echoes summative evaluations (see Chapter Six). The remaining two children (both male) were recruited from a local after-school club for children with special educational needs.

Table 10: Child participants involved in testing the high-fidelity prototype

Participant	Age (years)	User Group
Steven	4	TD
Alan	6	TD
Noah	8	TD
Daniel	8	ASC
James	8	ASC
Alison	13	ASC

As part of the Echoes summative evaluation, Alison's receptive vocabulary was assessed using the British Picture Vocabulary Scale (Dunn et al., 2009) and found to be 5 years and 11 months, indicating some developmental delay. The other two participants with Autism Spectrum Conditions (Daniel and James) could not be assessed due to time constraints. However, both were recently assessed by educational professionals who confirmed the diagnosis and developmental delay.

7.3.2. **Materials**

The sharing tool prototype ran on a MacBook laptop and was based on the original design resulting from the work conducted in Chapter Eight. One participant interacted with the software using a 42" multi-touch screen. The remaining participants interacted using a 32" touch screen. Also required were paper cut-outs of 'tops' and 'pants' (see figure 20)[7], colouring pens, a washing line and some pegs.

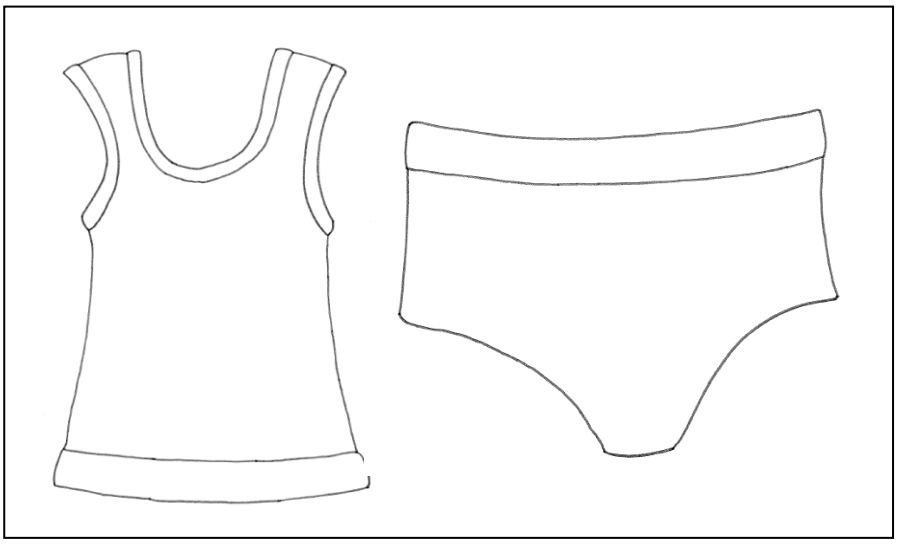


Figure 20: Top (left) and pants (right)

7.3.3. **Procedure**

Each child interacted with the sharing tool for one session lasting a maximum of 30 minutes. The typically developing children participated as a group. Participants with Autism Spectrum Conditions interacted with the sharing tool individually but were accompanied by an appropriate caregiver who provided support and facilitation when required. This included

[7] These were originally developed by Dundee Science Centre as part of the "Debate It Out!" Program (http://www.sensation.org.uk/index.php?p=330, accessed 7th April 2012).

physical assistance using the screen or providing prompts and encouragement as required by individual children.

To begin the session, the researcher set the customisation values with advice from an adult who was responsible for each participant. The participant was then introduced to the system at the screen displaying their name. During these sessions, the recorded audio speech for the character on screen did not use the child's name during the interaction, as there was not sufficient time to record each name before the child participated in the study. However, this was implemented in the final sharing tool used in the summative evaluation. Each child completed one sharing scenario followed by a bubbles activity, with a transition screen showing the schedule before and after each activity. The final transition screen was the successful end point of the interaction. On completion, the participants were given the opportunity to use the system again if they wished.

The researcher allowed the children to work through the sharing tool at their own pace, only providing help and assistance when the participant was either having difficulties or specifically requested assistance. Participants were encouraged to speak about their use of the sharing tool throughout, with the researcher asking questions to gather their feedback. This feedback included their opinions of the characters, how easy the screen was to use and their favourite and worst part of their experience interacting with the sharing tool.

Additional input of typically developing participants

Further work was undertaken by the typically developing participant group in order to more fully gauge their opinions of the sharing tool. The participants were given 'top' and 'pants' cut-outs (figure 20) to show their most and least favourite aspects of the system. These were shown to the participants after their interaction with the sharing tool and they were asked to

either write or draw on the cut-outs, which were then hung on a washing line to encourage discussion. This activity has previously been used in school-based activities to allow children opportunities to express their opinions in a non-verbal and non-threatening manner.

Due to external constraints, the sessions could not be video recorded. Instead, the researcher took narrative notes during and immediately after each session.

7.4 Design evolution through formative evaluation

As the primary user group of the sharing tool, the opinions of the child participants were determined to be of particular importance. Their opinions were sought both during and after their interaction with the prototype and are summarised in table 11. These were considered, along with the interaction of the children with the system, and relevant solutions were discussed with stakeholder groups where appropriate. The solutions implemented are reflected in the final sharing tool to be used during the summative evaluation phase of the research.

Table 11: Summary of child opinions[8]

Participant	Top (Like)	Pants (Dislike)
Steven	Bubbles	"Funny bubbles" (the orange bubbles that made an alternative sound)
Allan	Orange bubbles and smiley face	*(Not completed)*
Noah	When the bubbles appear from the bricks	Tom is too slow
Daniel	(Particularly focussed on the schedule)	Orange bubbles
James	(Enjoyed listening to Tom's speech. Repeatedly moved bricks to the wrong pile and waited for him to speak)	Bubbles – these meant that Tom would no longer speak
Alison	*"Tom is funny"*[9]	Bricks are difficult to move.

7.4.1. **Customisation screen**

There were a number of issues raised by the practitioners and usability experts concerning the customisation screen. The initial customisation screen as seen by participants is shown below in figure 21, with the changes implemented described below and shown in figure 22.

[8] ( ) denotes opinions deduced by the researcher.
[9] "funny" means that Alison is enjoying the interaction.

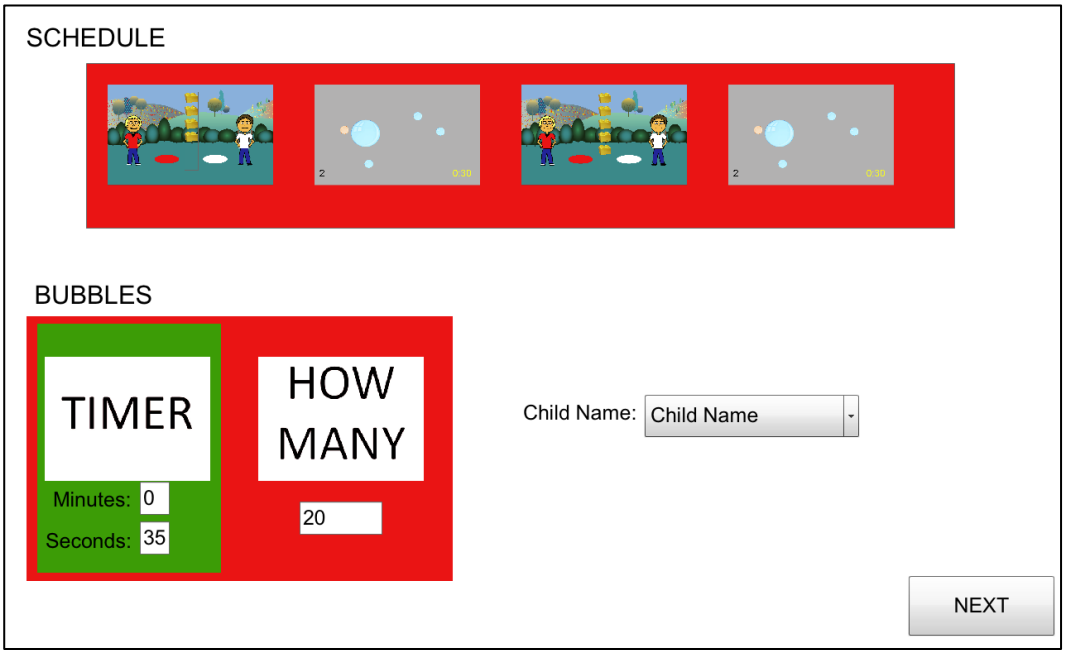


Figure 21: Customisation screen before formative evaluation

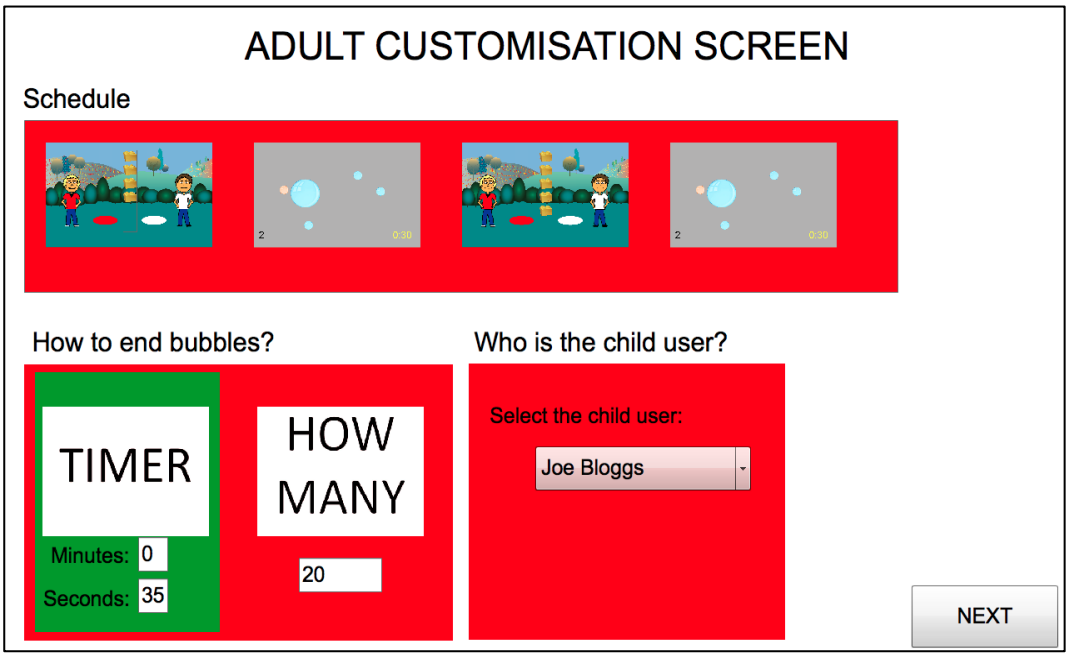


Figure 22: Customisation screen after formative evaluation

Main heading

The customisation screen is the first screen of the sharing tool and was shown only to practitioners and heuristic experts, since the child users are not expected to customise the tool at this stage. Some participants were unclear as to the purpose of this screen. While the contents of this screen give an indication as to its purpose, there is no heading to make this clear to the user. Therefore, a heading was added to the main customisation screen (see figure 20).

Headings for all grouped items

There are two headings on the customisation screen, for "schedule" and "bubbles". However, there was no consistency with a heading to indicate the child user selection drop down menu. Participants reported that the purpose of the drop down menu was not immediately clear.

In order to rectify this, a "child user" heading was added (see figure 22). Furthermore, a red box was placed in the background around the drop down menu. This ensures consistency with the other customisation options available on this screen, and serves to encourage practitioners to select a specific user and so provide a fully customised experience.

The precise headings were also adapted, following discussions with participants. The headings included in the final version of the sharing tool include interrogative words such as "how" and "who", which encourage the users to consider the purpose of their actions. This means that the sharing tool is precisely customised for the needs and abilities of individuals.

Keyboard

Practitioners conducting the evaluation reported a practical issue when having to specify the end point of the bubble activity. This involved typing in the number of bubbles to pop or the time limit for the timer. When the laptop was set up in school, the practitioners had to move to the laptop to enter and edit these details rather than only using the touch screen. This was not previously uncovered, as previous software iterations had involved prototypes being displayed on the laptop or a simple walkthrough of only the sharing scenario on the touchscreen.

During the final formative testing, it was noted that the interaction of the practitioner with the screen was interrupted when having to switch to the laptop and back in order to make changes to the sharing tool. In addition, if a child was present in the room during the setup, this switch tended to alert them to the presence of the laptop, which often became the focus of their attention, at least in the initial stages. During this formative evaluation, practitioners suggested using a soft keyboard or a slider bar to make changes.

Subsequently, a number of low fidelity prototypes were developed by the practitioners (see figure 23) in order to investigate whether a soft keyboard or slider bar would be more effective for participants to make changes to the default values.

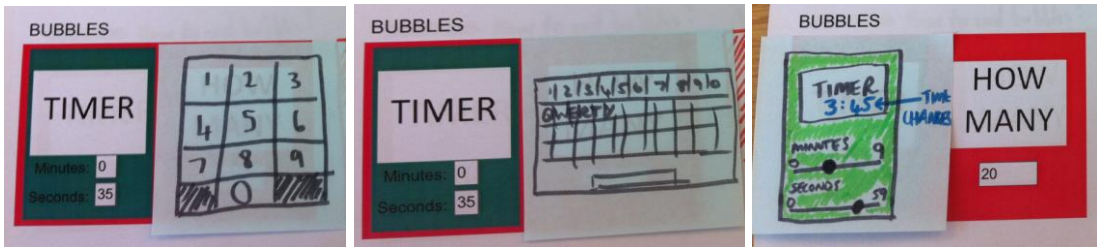


Figure 23: Options for entering numerical values

Practitioners considered these prototypes and were given opportunities to explore both options before selecting their preference. Options included a slider bar with pre-set minimum and maximum values, a full QWERTY soft keyboard and a numerical soft keyboard. Three practitioners were involved in creating early sketches for these options and, ultimately, selecting their preference. Of the three options considered, the slider was preferable as this was a clear visual representation of the numerical values. However, all practitioners expressed concerns regarding the selection of minimum or maximum values, since this imposes bounds on the values that can be selected. Since children with Autism Spectrum Conditions may be best suited to working at extreme ends of this spectrum, practitioners indicated that compromise would be required. They suggested that the use of a soft keyboard would be more practical in the classroom setting. The use of such an input would allow the practitioners freedom in selecting values for individual children and thus ensure that a personalised experience can be provided for each child who uses the sharing tool.

Recovering from errors

When setting the customisation options, the practitioner must make three selections: (1) whether to determine the end of the bubbles scenario by a timer or number of bubbles, (2) the values associated with this decision and (3) the name of the child user. After setting these values and selecting ‘next’, the child is presented with the screen to select their name and begin the sharing tool scenarios (see figure 24).

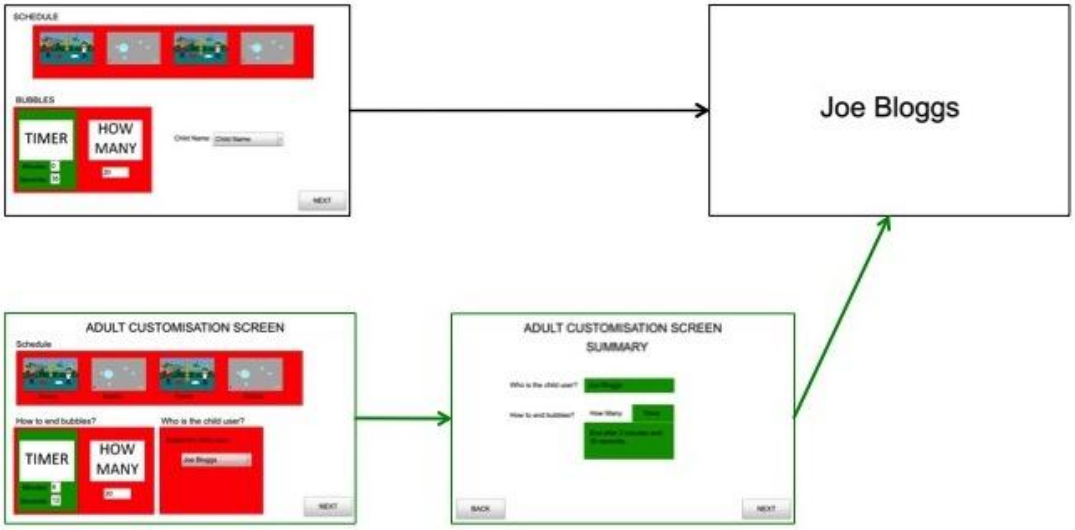


Figure 24: Original screen flow with adaptations shown (in green)

However, practitioners and usability experts alike expressed concern that errors were not able to be rectified, and that there was no way for the adult users to recover from an error, such as selecting the wrong child's name.

Again, low fidelity prototypes were used during practitioner interviews to explore how this issue should be addressed. One option discussed was the inclusion of a 'go back' option on the initial child screen, which displays the child's name. However, this was quickly rejected as a possibility since the children may select it and thus be exposed to the customisation options. Instead, it was proposed that a summary screen be presented to the practitioners (see figure 24), showing a summary of preference selections made.

On this screen, there is an option for users to confirm the customised options or return to the previous screen to make changes, either to rectify errors or simply to change their preferences. When the summary of selections is confirmed, the sharing tool will proceed as previously to the name selection screen. As before, there will be no option to return to the

previous screen. This is typically considered to be poor usability (Nielsen, 1994), since there is no option for users to recover from errors, or to move backwards. However, it is determined by the practitioners to be a necessary feature of the sharing tool, in order to minimise possible distractions for the child users.

7.4.2. **Sharing scenario**

The sharing scenario is one of the main areas of the sharing tool with which children with Autism Spectrum Conditions will interact. The evolution of the design of this section was influenced by input from typically developing children, children with Autism Spectrum Conditions, practitioners and usability professionals.

Moving objects around the screen

The default drag and drop functions within the Flex framework were utilised to implement the drag and drop functions in the first high-fidelity prototype of the sharing tool. As a result, the default icon for an item being dragged was displayed (see figure 25). This caused some confusion for the children who used the system, with comments including *"it's like it's invisible. It's too hard"*. The icon, while being common in file structure movements, was too abstract for the children to fully comprehend. As a result, some participants were confused and were unable to move the objects around the screen. This was particularly concerning, as movement of the objects around the screen is crucial to achieving success and progressing to the bubble scene. The failure of the participants to achieve this success led to frustration. In addition, some participants were anxious that they were not "doing it properly".

Practitioners further reinforced this potential for anxiety, and advocated for the image of the object being present at all times. The lack of comparison with the real world situation of sharing was clear, as moving objects between individuals in reality does not result in the object disappearing whilst in transition. The sharing tool is shown below in figure 25, with the solution clearly displayed on the right.

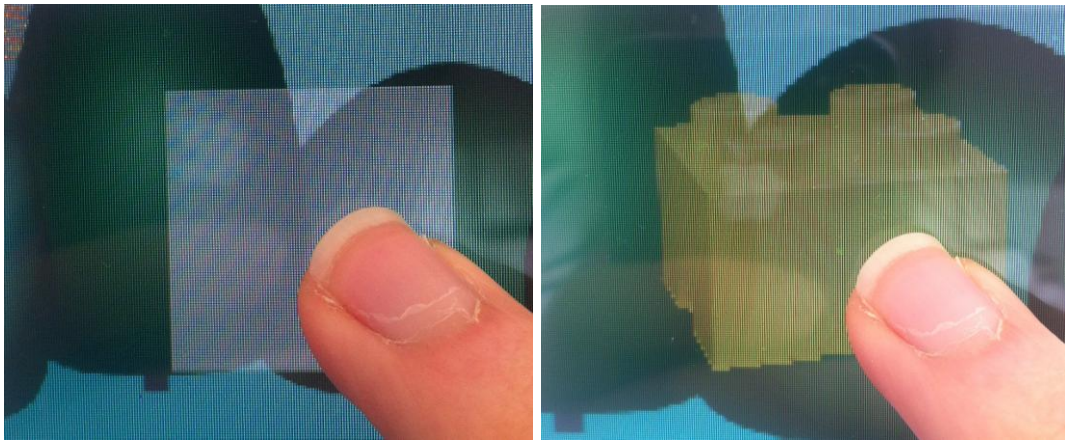


Figure 25: Original drag drop icon (left), revised drag drop icon (right)

Characters

Based on previous studies, such as the Echoes evaluations, the characters were designed to respond immediately to actions performed by child users, but to perform the interaction slowly, e.g. by only giving one piece of information at a time, so that the child had time to process that information. The responses of the character to inactivity were set to 10-second intervals after the previous action. Thus, if the character makes a request and the child does not respond within a 10 second period, then the character will repeat the request or provide further information where appropriate.

Of the participants involved in the formative evaluation, the typically developing children often became frustrated because the character was too slow. They frequently pre-empted the

characters explanations or requests in order to speed up the interaction, particularly once they had experienced the sharing tool. However, the participants with Autism Spectrum Conditions did not have this issue. Like those participants in the Echoes summative evaluations, the participants with Autism Spectrum Conditions initially found it difficult to adjust their interactions and slow down their speech and impulsive interactions. They were, however, able to adapt to the slowed speed of interaction and thus experience success as a result.

7.4.3. **Transition screen**

The transition screen is of particular importance for children with Autism Spectrum Conditions, since maintaining a clear structure is imperative to maintain engagement and to reduce anxiety.

Icons on schedule not labelled

On the transition screen, the icons on the schedule are clearly shown and are linked to the upcoming scenarios. The practitioners enthused about the use of visual screenshots, since children with Autism Spectrum Conditions are often visual learners and visual thinkers (e.g. (Grandin, 2002)). Furthermore, children with Autism Spectrum Conditions can often find symbols to be too abstract, particularly when presented with novel symbols. This was evident in the interaction of children with the sharing tool, with participants (both typically developing and with Autism Spectrum Conditions) repeatedly asking the researcher what the images meant. This was particularly true for the screenshot depicting the ‘sharing’ activity.

Replacing the images with PECS symbols (as was used daily by the participants with Autism Spectrum Conditions) did not alleviate this issue.

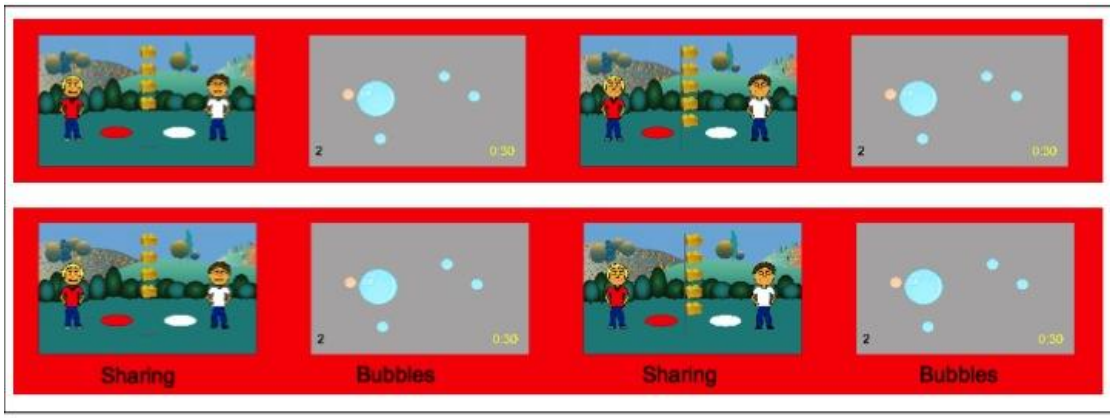


Figure 26: The original schedule (above) and with labels (below)

Following interviews with practitioners, labels were added to the schedule to indicate 'sharing' or 'bubbles' as shown in figure 26. These were clearly understood by the children using the system. In the case of formative testing, most of the children were literate. One child was unable to read independently, but the practitioners considered the use of labels an advantage in this case, as this represented opportunities of cross learning for literacy.

While adding labels to the schedule reinforced the meanings of the images, this gave rise to a further interaction challenge. Once the labelling was added, the participants tried to select the label rather than the image. When the sharing tool did not recognise this selection, the participants became frustrated. For verbal participants this was apparent in their use of language (e.g. *"Argh! Just go!", "I did it… now move!"*) and for non-verbal participants this was clear in their actions and behaviours (e.g. walking away from the system, punching the screen or crying). In order to rectify this, both the label and image can be selected in order to proceed to the next activity.

Not clear what can be selected

When the child encounters the transition screen, the schedule is displayed (see figure 26). As an activity is completed it is crossed off the schedule and the next activity is displayed with a green box around it. This was originally considered as being sufficient to attract the child's attention to it as the item to select in order to proceed through the schedule. However, this was not always the case, as participants with Autism Spectrum Conditions needed prompting to continue interacting with the sharing tool. A possible solution, in order to smooth the interaction of the participant with the sharing tool, was to display the schedule for a set time period before moving on to the next activity. However, this contravenes the requirement set by practitioners that the child is in control of the pace of the interaction. In order to attract further attention to the schedule and to encourage the participants to make the appropriate selection, the green surrounding box was replaced with a flashing green surround. The participants found this to be much more engaging that the previous static version and required less encouragement to press the next activity on the schedule.

7.4.4. **User cannot tell the state of the system**

The usability experts considered that the system could potentially violate the "visibility of system status" heuristic (Nielsen, 1994), as the user's position in the schedule is not always clear. The usability of the system is outwith the scope of this thesis, but was also noted by a number of practitioners. In the classroom, paper-based schedules are always available for consultation, but the schedule in the sharing tool was only visible on completion of a sharing scenario or a bubble activity. For this reason, it was suggested that the schedule be either permanently visible on the screen or accessed on demand by pressing on a schedule button.

A number of paper prototypes were created to explore this possibility, examples of which are shown below:

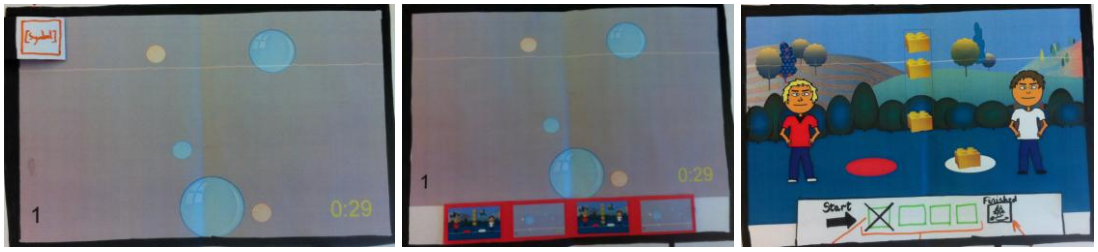


Figure 27: Examples of prototypes showing schedule display options

Children, both with Autism Spectrum Conditions and without, used these prototypes in a high-fidelity form. The typically developing participants were unconcerned as to whether the schedule was available or not. For example, these participants touched the button to display the schedule once, but thereafter did not attempt to view the schedule. For this user group, the transition screen was sufficient to show their progress through the sharing tool. The participants with Autism Spectrum Conditions differed. These participants became very focussed on the schedule that was displayed on the screen and verbally confirmed that it had progressed after each scenario. When the prototype with the hidden schedule was used, the children were focussed on this and spent a considerable amount of time confirming the schedule by selecting the option on screen to display it, often to the detriment of their interaction with the task. As a result of these observations, and following discussions with practitioners, it was determined that having the schedule continually available to the participant would be distracting and that, in fact, a desire to view the schedule may provide a motivation to complete the current task.

7.5 The participation of children with autism spectrum conditions

Three children with Autism Spectrum Conditions participated in testing of the high fidelity prototype of the sharing tool. One female participant had previously been involved in research, being a participant in the summative evaluations of the Echoes project. Therefore, she was familiar with the researcher being present. Through her previous interactions with the researcher she had become accustomed to providing verbal opinions based on her likes and dislikes. While the corresponding explanations were often absent or difficult to comprehend, she readily provided opinions, often without prompting. This provision of opinion has developed through time, as she was often shy and reserved when involved in conversation.

The two participants not previously involved in the research were initially uncomfortable in the presence of the researcher. In fact, much initial reassurance and prompting was provided by the accompanying caregiver (in both cases, this was the participant's mother). This was advantageous as it allowed the child opportunities to relax and alleviate any anxiety experienced as a result of the 'new' situation. However, this meant that early behaviours of the child could not be explored fully by the researcher. For example, one child began to prod the character on screen with a finger; an action that was ambiguous. It was possible that the child was being friendly with the character, but it was also possible that this action was hostile. When prompted by the researcher to explain this action, the child became anxious and retreated to a corner of the room, away from the researcher and the screen. This was repeated many times whenever the researcher spoke and so the researcher was unable to be involved in prompting the child further. Communications with the mother were limited since she was focussed on reassuring the child. The need for an introductory phase is clearly highlighted in this case, whereby the researcher becomes involved in the child's typical

environment before introducing the new software, as was the case during the design and summative evaluation studies.

7.6 The participation of practitioners

In addition to being engaged in the initial design phase, the practitioners participated enthusiastically in the formative evaluation sessions. Much of the work in these sessions focussed on the process of customising the sharing tool interaction for individual children. Practitioners explained that being involved in this phase of development allowed them to consider individual children they regularly worked with outwith the confines of their regular working environments. One practitioner said, *"It's brilliant being able to just step back and kind of consider the issues from a distance. When you're in that situation every day you become so invested in a solution, it's so nice just to have this opportunity to consider some different approaches you might want to try"*. This highlights the opportunities practitioners had within the research to consider creative approaches to therapeutic issues encountered in their professional capacity.

However, there was reluctance on behalf of the practitioners to openly criticise work presented to them, which was completed by other practitioners, even though they did not necessarily know other participants in the study. Often, practitioners indicated that they disagreed with opinions or suggestions represented in the prototypes, but were hesitant to follow through with reasons for their differing opinion. When this was discussed, one practitioner commented that, *"It's a professional courtesy. I don't want to be bad-mouthing my colleagues and their ideas"*. This meant that a particular effort was made on behalf of the researcher to reassure practitioners about the confidentiality of their contributions and the iterative, idea-gathering nature of the research.

7.7 Summary

This chapter describes the evolution of the design from the initial design prototypes to the software used in the summative evaluation testing through formative evaluation. Focus groups and interviews with practitioners were utilised to ensure that the design was developmentally appropriate for the target user group and also that the design was best suited to allow practitioners opportunities to customise and operate the sharing tool. In addition, children both with and without Autism Spectrum Conditions were observed using the system. Their opinions were then sought in order to ensure that the design was likely to be accepted by the participant group and that children were able to make use of the sharing tool without preventable difficulties.

Through the active involvement of practitioners and child users, changes were made to all aspects of the system. The input method for customisation by practitioners was altered to increase the ease of use; changes were made to the transition screens to increase understanding and changes to the visual interaction were made within the sharing scenario.

Chapter 8. **Implementation of the sharing tool**

An outcome of this research was the development of sharing tool software, which aims to allow children to explore and acquire social skills related to social sharing behaviours. Specifically, these skills are concerned with the division of objects and turn taking, as per the research conducted in Chapter Six. This chapter describes the implementation of the final sharing tool and includes a system walkthrough, indicating the potential interactions that a user may have with the system. Design decisions are highlighted with reference to the design specification (Appendix A), developed as a result of the work described in Chapter Six.

The sharing tool was developed through User-Centred Design methodologies. Firstly, initial requirements were gathered and a low-fidelity design was created. This was conducted with the involvement of children and practitioners in the design of the interface and interaction. The outcome of this initial design phase was the production of low fidelity prototypes (storyboards and interface sketches) and a design specification document.

These low fidelity prototypes were then implemented as mid-fidelity prototypes such as PowerPoint presentations and subsequently as high-fidelity prototypes. Formative testing was then undertaken, which is described in Chapter Seven. This included pilot testing with potential end users and confirming the design implementation through interviews with a variety of practitioners.

8.1 System walkthrough

8.1.1. Customisation

Interaction with the sharing tool begins with the screen shown in figure 28 and requires some customisation by an adult (indicated by arrows) in order to promote engagement. For the purposes of this research, either the researcher or classroom staff carried out the customisation, based on their knowledge of the child and how best to motivate them. Future versions of the tool may incorporate a child profile, which will remove the need for this step each time the software is used.

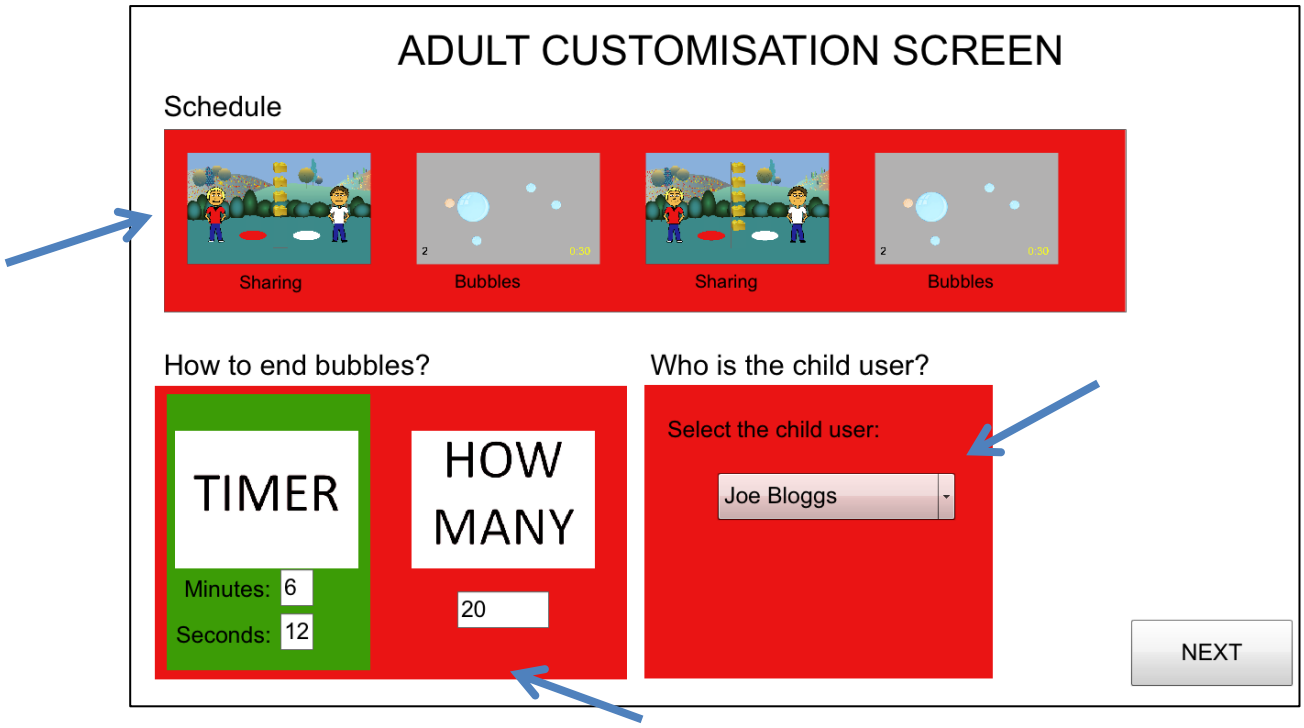


Figure 28: Adult customisation of the sharing tool

This view displays the schedule for the child, indicating that the child will complete two sharing scenarios, with each one being followed by a bubble-popping scenario. The adult responsible for the customisation can select a name from the drop down list, which is

populated with participant details. This name is used later in the child's interaction with the sharing tool to have the characters address the child by name. Finally, the adult can select the end point of the bubble-popping activity. There are two options: the system can show a timer, with the adult selecting how long each bubble-popping activity should be, or alternatively the adult can set a value of how many bubbles the child may pop before moving on. This can be set to reflect timing strategies currently used in the classroom when working with an individual child.

Further customisation may be incorporated in the future, with the use of themes as was investigated by the 'What objects?' design workshop in Chapter Six. The background, objects to be shared and characters within the environment could all be modified to fit themes including space, fantasy and animals. The use of themes will likely encourage the child to engage with the system, but may have implications for the generalisation of knowledge and skills. For example, it can be difficult to set the context of reality for skills learned in the realm of fantasy as shown by (Tan, 2000). Notwithstanding these benefits, the customisation of the sharing tool by introducing themes is considered to be outwith the scope of this research development.

Once the adult has set the appropriate selections and touched the "next" button to move on, a summary screen will be displayed, as in figure 29.

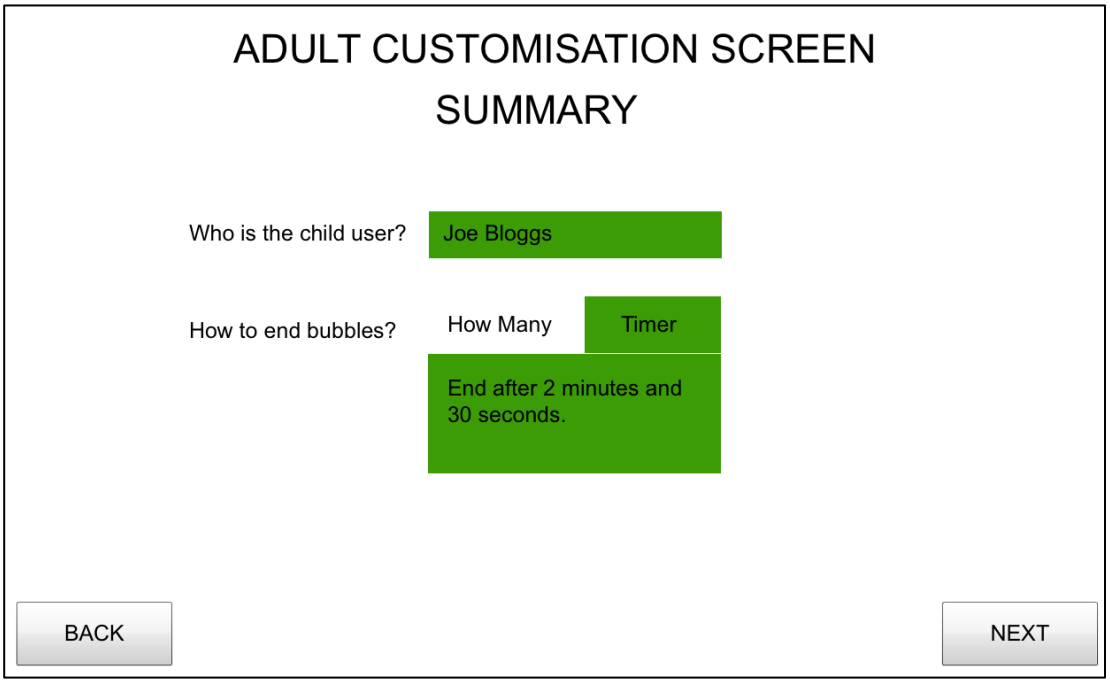


Figure 29: Summary screen

This displays the selections made by the practitioners in the customisation screen, in summary form. This gives the adult an opportunity to view the selections made and to correct any errors. In order to correct the errors, the adult can touch the “go back” button, which will return them to the original settings customisation screen. If the options displayed are correct, then the adult can again press “next” to proceed. The sharing tool will then display the child’s name.

8.1.2. **Child learner screens**

When the child’s name is displayed, as in figure 30, the sharing tool is ready for use by the child. This view shows the child’s name set against a white background; a minimal approach which can help to eliminate distractions.

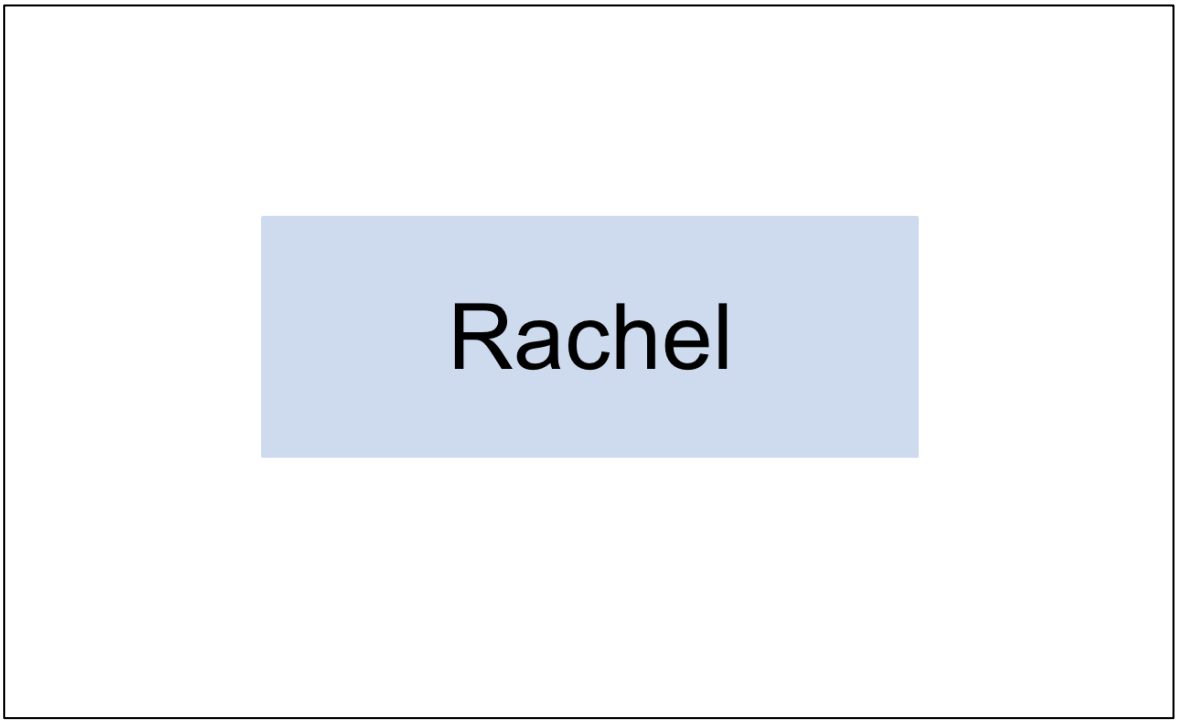


Figure 30: Displaying the child's name to begin

The child should touch their name to begin the start of the interaction by loading the initial sharing scenario. Beginning the interaction in this way allows the child to exert control early on, and thus can help to reduce any initial anxieties. In this research, all children were literate. However, in future work the name could be replaced with a symbol or other suitable alternative, such as a personal photograph, which the child can easily identify.

At this point in the interaction, it is impossible to move backwards. This was a deliberate design decision made to reduce the interaction possibilities for the child on their initial contact with the sharing tool, and also to avoid the child having access to the customisation screen. This was determined as a result of the evaluations outlined in Chapter Seven.

Touching the name leads to the sharing scenario (figure 31), the main scene of the sharing tool. The child has the task of sharing the Lego bricks in the middle between the two characters on screen.

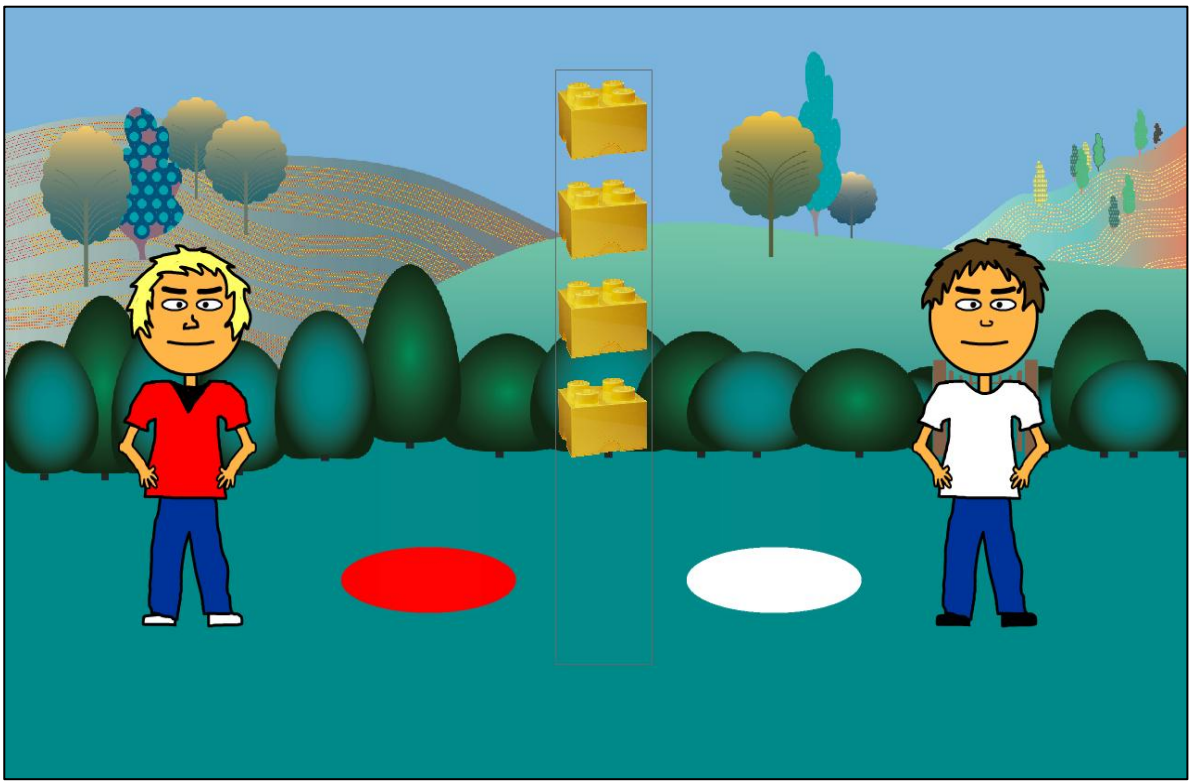


Figure 31: Sharing scene: initial presentation

The background of this view is the garden background used in the ‘What Object?’ design activity (see Chapter Six). The objects to be shared are presented in the centre of the screen, with the purpose being to move them into the coloured spots, which indicate the personal area of the two characters. The characters, named Tom (left) and Robert (right), are presented as simple animations in order to avoid distractions such as extraneous gestures or ambiguous movement. The characters represent an age-matched peer in order that the sharing tool has some elements of realism that can connect to the child’s current

environment. The speech is pre-recorded by an age-matched peer to reinforce this realism. In addition, the children were expected to respond well to highly emotive and enthusiastic speech, as determined in Chapter Six.

To begin the sharing scenario, Tom speaks directly to the child, appealing for help to share the objects with his friend. If the child does not respond he will further seek their attention by either repeating his request or giving more specific instructions. The child can then drag the objects around the screen into the smaller circles in order to share them. The scenario is completed when the appropriate number of objects is placed in each circle, such that the objects are evenly shared. For each object, a bubble appears, which signals the end of the activity. At this point in the interaction, the child is once again in control, as the system will not move on until the bubbles have been popped.

Once the bubbles have been popped, the sharing tool will display the transition screen (figure 32).

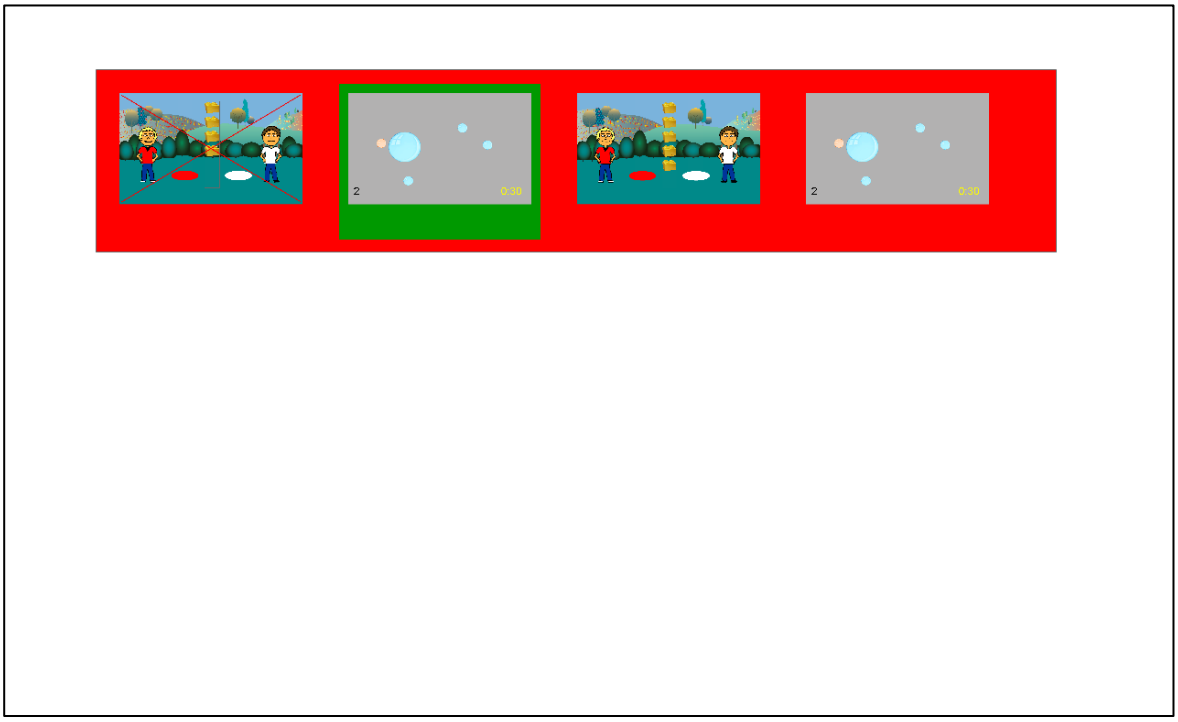


Figure 32: Transition in the sharing tool

This screen shows the timetable previously confirmed in the adult customisation screen, with the completed activities crossed off and the next activity highlighted by a green surrounding box. Again, a blank background is used to minimise distraction and to focus the child's attention on the objects of interest, in this case, the schedule. By crossing off the completed activities, the progress of the child through the system is clear. Here, the first sharing activity has been completed. In order to move onto the next activity on the schedule, the child should touch the relevant activity; in this case the first bubble activity. The sharing tool will not allow the child to move onto any activity other than the next one on the schedule. Furthermore, the child is in control of the timing of the transition. The schedule is shown only between activities. This was a considered design decision to avoid information overload and distractions as described in Chapter Six.

Once the appropriate bubble popping activity is selected, bubbles are presented on the screen (see figure 33), which are 'popped' when the child touches them. The purpose of this activity is to allow the child opportunities for emotional regulation and relaxation before tackling the subsequent sharing scenario. It provides an opportunity for the child to self-regulate any residual anxiety that has resulted from the exploration of sharing skills.

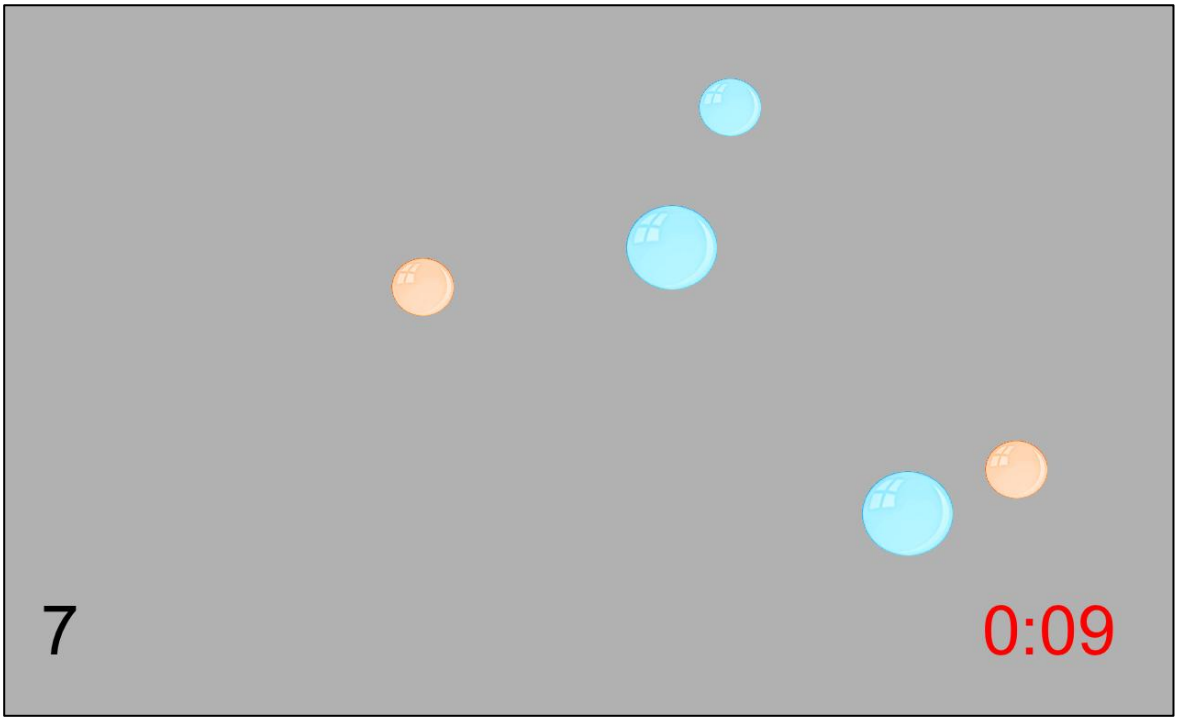


Figure 33: Bubble popping in the sharing tool

On the bottom-left of the screen, the number of bubbles popped is displayed. This is seen as a motivator by some children, and is related to the initial customisation option seen in figure 28, whereby the adult can set the activity to finish after a set number of bubbles are popped. On the right side, the timer is shown. However, this is only displayed if the timer was selected on the initial screen as the end point of the bubble activity. The initial colour of the timer is black, but when only 10 seconds of the bubble popping activity remain, the timer is

displayed in red in order to draw the child's attention and to indicate that time is running out.

Also of note on this screen are the different coloured bubbles. Blue bubbles are the predominant colour and touching these results in an expected 'popping' sound. These bubbles can grow in size when they collide and the volume of the popping sound is related to the size of the bubble; popping larger bubbles results in a louder popping noise. The orange bubbles, however, do not collide and touching these bubbles will result in an alternative 'chime' sound. These non-conventional bubbles allow the children opportunities to make discoveries for themselves based on their own exploration of the environment.

On completion of all sharing and bubble popping scenes shown in the schedule, the child is presented with the final transition screen as below shown in figure 34.

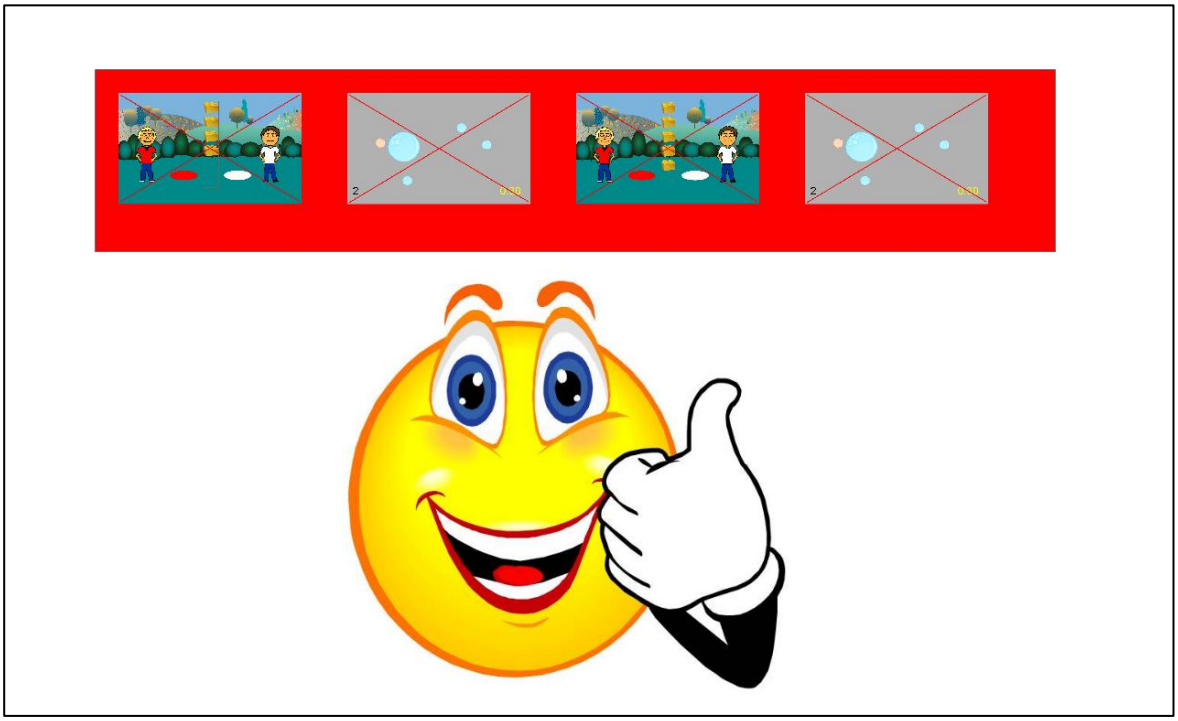


Figure 34: Final transition screen in sharing tool

All activities are crossed out, indicating that the scheduled activities have come to an end. This is presented as a successful outcome for the child, with an emoticon showing a smile and a ‘thumb-up’ gesture, which relates to the same gestures used by school staff. This is accompanied by an auditory sensory reward of applause and cheering. This applause lasts for approximately 10 seconds. Touching the happy face will re-initiate this repeatable praise. The child can control how much of this feedback is presented to them, as repeatedly touching the happy face will result in the volume of applause increasing. This affords a further opportunity for exploration by the child.

8.1.3. **Alternative sharing scenario**

There is one alternative to the presented sharing scenario, which has been designed within the wider context of the sharing tool activities in order to promote generalisation of the skill to reality. After a number of interactions with the sharing tool, the adult may replace the original (animated) sharing scenario with one using only static images (see figure 35).

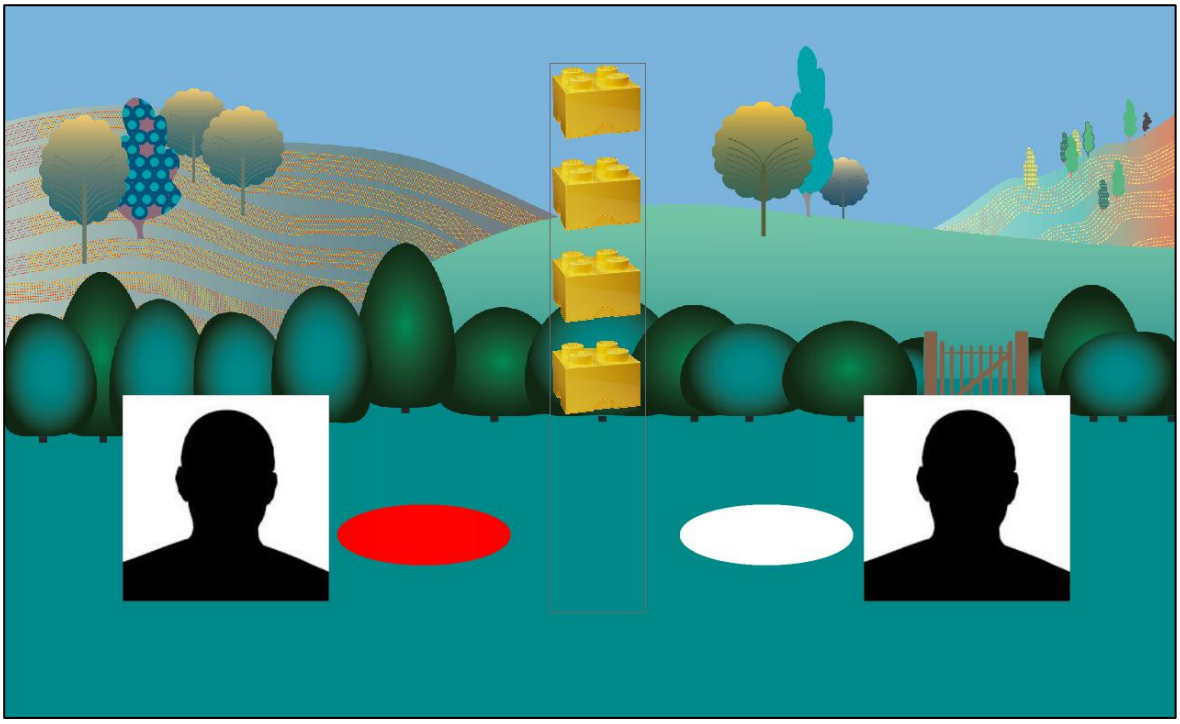


Figure 35: Alternative sharing scenario

These images are of the child and a peer interaction partner. The use of an image of oneself it useful as it can guide the child to understand that this skill can be applied to them, and that it is not limited to the animated characters presented by the sharing tool. Furthermore, the use of a peer image may assist in relating the sharing skill to the context of use and wider environment by reducing abstraction.

8.2 Development of the sharing tool

The sharing tool software was developed using Adobe Flash Builder 4.5. This makes use of Flex SDK 4.5 and Actionscript 5.0. Flex was selected as the development framework, since it allows for the creation of applications that run on a number of different platforms including desktop, browser and mobile applications. Adobe Air runtime allows the sharing tool to run as a stand-alone application.

The front-end interface is coded using MXML, a markup language, which is separated from the back-end Actionscript code. This means that ad hoc changes to the interface, such as in Chapter Seven, can be made without the underlying code being significantly altered. It also allows for the development of software that makes use of high-fidelity interface prototypes.

For the purpose of this research, a large multi touch screen was used as the medium of access to the application (see figure 15). Touch screens are one of the most direct and intuitive interfaces (Albinsson and Zhai, 2003). The information display and controls are the same, thus allowing for a direct form of interaction (Mahmud and Kurniawan, 2005). Using a large touch screen rather than a smaller device, such as an iPad, allows the user to engage in a more active experience, since the user may move around in space and interact with the screen in novel ways. Furthermore, the children were observed using such touch screen interfaces successfully during the Echoes summative evaluation studies (see Chapter Ten). The sharing tool is run on a MacBook Pro, which connects, to the touch screen by means of a USB connection.

Chapter 9. **Case studies**

An experimental study was devised and conducted in order to evaluate the sharing system. The experimental design lends itself to the gathering of both qualitative and quantitative data, which can assess the impact of the sharing system on the development of social skills and the generalisation of these skills to new situations without the school environment. This chapter outlines the experimental methodology and analysis of two case studies before providing the results and subsequent discussion.

The purpose of the summative evaluation was to address the following research questions:

a. Can social skills, in particular sharing, be improved in Autism Spectrum Conditions through the use of a computer-based tool designed specifically to support this?
b. Do any improvements, i.e. in knowledge or skills, carry through to a wider social context?

The experimental protocol involved the participant using the sharing system twice per week for five weeks, while being supported by the researcher and/or a Support for Learning Assistant (SLA). Participants interacted with the system alone or with a peer to explore their social and sharing skills. The experimental protocol was similar to that used in the Echoes evaluations, but differed in three particular aspects. Firstly, the number of possible scenarios for the child to interact with was fewer than during the Echoes evaluation. In this research there are only two scenarios that focus very directly on a specific skill. This allows for repetition of the skill in the same environment while introducing peer interaction to give opportunities for generalisation. Secondly, the use of a peer arises from work by Delano (2006) in the area of social stories. In the work by Delano, a novel peer was utilised in order to assess the level of skill generalisation. However, in the current research, the desire is to

achieve a generalisation of skills through exposure to peer interaction and so the peer is introduced as a familiar social partner. The purpose of this is to give the participant opportunities to explore any new skills learned with a familiar peer, thus avoiding any confounding social anxiety resulting from the introduction of a novel social partner. Finally, the role of the researcher differs. In the Echoes evaluations the researcher attempted to adopt a passive role in order to allow a one-to-one interaction between the child and the on-screen character. This is typical of the researcher role in experimental research. However, in this case, the researcher is actively involved in the interaction between the child and the character on screen, modelling peer behaviours and offering advice and encouragement. The purpose of this was to create a more social environment to foster the development of social skills and is typical of the participatory and ethnographic approaches used throughout this research, in which the active involvement of the researcher is paramount.

9.1 Pre-assessment

In the early stages of the research, the six participants involved in the Echoes summative evaluations were recruited to participate in the evaluation of the sharing tool. From the focus on joint attention and turn taking within the Echoes environment, the progression to sharing was a natural one. Prior to the commencement of the evaluation of the sharing tool, the sharing skills of these six participants were evaluated, in order to assess the level of sharing skills and the typical application of these within social situations.

In order to evaluate the sharing skills, the participants played a Lego game with the researcher which involved sharing. The participants were given some Lego bricks and invited to share them between them self and the researcher, with Hula Hoops laid on the floor and used to indicate areas of ownership. Of the six participants, four shared the bricks

correctly over three trials at different times of the school day. During follow-up discussions with classroom staff, it was clear that these participants were able to complete sharing tasks and show the skill when directed, but had difficulties in initiating sharing behaviours with peers. Since the focus of the sharing was to give opportunities to explore the basis of sharing skills, the tool was considered unsuitable for use by these participants. It was considered that their involvement in the study would very quickly result in a ceiling effect. While their involvement in the study could be useful in providing opportunities for applying social skills in a safe environment, it was decided that the participants would not benefit from using the sharing tool. Therefore, the four successful participants were excluded from the evaluation of the sharing tool, with the two remaining participants being involved on a case study basis. The option of including further participants from another location was considered, but since the sharing tool runs on a specific multi-touch screen, the technology required was limited. In addition, over two years was spent working within the school, and so participants from another school would not have had the benefit of this time to ensure that participants are comfortable with the researcher and taking part in the study.

9.2 Participants

Two children (both male) with Autism Spectrum Conditions participated in the study. They were chronologically aged 13 years 8 months and 14 years 4 months at the beginning of the study. One participant (Craig) had a receptive vocabulary age of 3 years 2 months at the time of the study, as determined by use of the British Picture Vocabulary Scale (Dunn et al., 2009), and associated learning disabilities. It was not possible to determine a receptive vocabulary age for Chris. The probability of a diagnosis of an Autism Spectrum Condition was confirmed by having the parents or primary caregiver complete a Social

Communication Questionnaire (SCQ) (Rutter et al., 2003a). A score of fifteen or greater indicates that further evaluation should be conducted for a diagnosis of an Autism Spectrum Disorder. Individual details for both participants are noted in table 12.

Table 12: Participant information

Participant	**Age (years)**	**Receptive Vocabulary age (years)**	**SCQ score**	**Age at Assessment (years)**
Chris	14	Not completed due to challenging behaviours	26*/35**	13
Craig	14	3:02	32	13

* Completion of SCQ questionnaire by mother.

** Completion of SCQ questionnaire by father.

A further two participants were recruited to act as peers for the participant when using the software. One participant (Alison) was previously involved in the formative evaluation, while the other (Kevin) was new to the research. Both have an Autism Spectrum Condition.

Table 13: Peer participant information

Participant	**Age (years)**	**Receptive Vocabulary age (years)**	**SCQ score**	**Age at Assessment (years)**
Alison	13	5:11	26	12
Kevin	8	Not completed due to challenging behaviours	26	8

All participants (except Kevin) are educated in the same specialised classroom for children with Autism Spectrum Conditions in a local special school. Kevin is a pupil at the same school, but in a different class. A range of augmentative communication techniques was employed including signing and the use of symbols. The use of these was dependent on the individual participant's needs.

Two professionals (Dawn and Heather) were involved in a support role. They provided educational and social support to the participants as required. Both are Support for Learning Assistants who work regularly with all child participants.

Two further professionals (Natalie and Margaret) were involved in the analysis of the data. Both are teachers at the same school and have some experience of working with children with Autism Spectrum Conditions.

Full descriptions of all participants are available in Section 4.3.

9.3 Materials

The software described in Chapter Eight ran on a MacBook laptop running Mac OS X, version 10.7.2. The participant interacted with the system using a 42" multi-touch screen (see figure 15). All sessions were video recorded using a Sony HDR-CX155 Handycam video camera.

A game named "Pop-Up Pirates", which was a familiar game used in class as a social activity, was used for the baseline videos. A similar game called 'Monkeying Around' was also used. For each child, an SCQ test was required along with a BPVS scorecard. One BPVS picture set was required to complete the assessment.

Figure 36: Pop-Up-Pirates[10] (left) and Monkeying Around[11] (right)

9.4 Procedure

9.4.1. Baseline and completion assessment videos

'Pop Up Pirates' is a game involving a pirate in a barrel whereby players place daggers into the barrel in pre-determined positions in order to have the pirate pop up from the barrel. Played during class time, the game involves an initial division of the daggers (sharing) and was used to indicate the baseline abilities of the participants in a typical structured setting. The participants were familiar with the game and had last played it one month previous to the session taking place. A familiar game was selected for this purpose in order to avoid the need for participants to learn the rules. The researcher and SLA supported participants where necessary. This included physical support, focussing on the task and managing self-regulation.

A similar game named 'Monkeying Around' was played after all sessions were completed in order to determine if any improvements were seen. In this game the players must take turns

[10] http://www.toysrus.co.uk/Toys-R-Us/Toys/Games/Games/Tomy-Pop-Up-Pirate-Game(0027195). Accessed August 13th 2012.

[11] http://www.amazon.com/International-Playthings-P25017-Monkeying-Around/dp/B00028A0Z0/ref=pd_sim_t_2. Accessed August 13th 2012.

to hang monkeys on the tree while trying not to bring down the treetop. Again, this game involves the division of objects, with the monkeys being divided between players at the outset.

9.4.2. Sessions with software

Participants attended 10 sessions (2 per week for 5 weeks) of approximately 20 minutes. The participants were accompanied by a Support for Learning Assistant (SLA) who provided support and facilitation where required. This included physical assistance using the screen or providing prompts and encouragement as required by individual children.

To begin each session, the participant started the system by touching their name, which was displayed on the screen. They then worked through the sharing scenario outlined in Chapter Eight, beginning with the animated character and progressing to the static images after at least 4 sessions and when the SLA considered them to be comfortable in working through the animated scenarios. These static images were one of the participant and one of the social partner. The social partner in this case was the researcher and therefore a portrait image of the researcher was used. This was the same image used on scheduling strips in the classroom. The participants were encouraged to engage with the software independently where possible. Whenever the participant displayed signs of distraction, they were re-directed to the sharing system by the researcher or support person.

The sessions were recorded in a number of ways. Firstly, they were video recorded in order that the videos be transcribed and coded. In addition, after each session, the researcher completed a diary entry, allowing each participant's progress to be monitored throughout the study. The diary contained information about the child's behaviour and reactions to the

system. Furthermore, this research diary also charted any changes or improvements seen in the classroom, which may be generalised from the software.

9.4.3. Sessions with software and a peer

Upon completing at least 5 sessions with the software, a peer was introduced (Alison). This was a child in the same classroom who was familiar to the participant. The peer was selected by school staff as being the most likely to encourage the participants in completing the tasks and with whom the participants were most likely to interact with. The participant and peer complete the sharing and bubble popping tasks together with support from the researcher or support person as necessary. Where appropriate, the static image of the social partner was one of the peer. Sessions with Kevin were unable to be conducted due to challenging behaviours and emotional dysregulation in the classroom.

9.4.4. Social validation

Social validity concerns the judgements related to the social importance of an intervention on three related levels (Wolf, 1978). First, the goals of the intervention must be socially important and relevant. The second is that treatment procedures must be socially appropriate. Finally, the effects of a treatment must be socially important or have meaningful clinical significance.

To assess these factors, the Treatment Evaluation Inventory – Short Form (TEI-SF) was used (Kelley et al., 1989). With previous use in school-based interventions (Rhoades and Krotochwill, 1998), the TEI-SF is a 9 item, Likert-type scale for assessing the acceptability of social skill interventions.

On completion of the study, the classroom teacher (Yasmin), the school Depute Head (Ruby) and the two Support for Learning Assistants (Dawn and Heather) were asked to complete the survey. This occurred during a de-brief meeting.

9.5 Analysis

The videos of each session (n=30) were transcribed in preparation for subsequent analysis. A detailed analysis was then undertaken. This analysis comprised two parts. Firstly, the videos were transcribed by the researcher, before being coded by the researcher and two teaching professionals. In addition an assessment of the overall level of engagement was sought from the same professionals. The purpose of this transcription and subsequent analysis was to determine the level of support required by the participants and the success of the participants in exploring the area of sharing.

9.5.1. Transcription

Each coding instance was defined by interaction. The word "interaction" is utilised within SCERTS (Prizant et al., 2008a, Prizant et al., 2008c) to indicate behaviours that are purposive and goal-directed. Included was behaviours directed towards a social partner without necessarily displaying a clear communicative intent, e.g. moving a person out of the way in order to reach something. The transcripts include interactions as being verbal or physical, between two people or between an individual and an object such as the touch screen. All incidences on the video were incorporated in the transcript, including all speech and interaction of the software. The focus was not on the software but on the behaviour and interactions of the participant.

The researcher undertook transcription and accuracy was confirmed by having an independent researcher verify 20% of transcripts (n=6). On completion of transcription, there were a total of 349 instances, 112 for Chris and 237 for Craig. Four videos were excluded from the transcriptions as the child participant did not appear on camera or interact with others.

9.5.2. Coding schema

The purpose of the schema was to code instances that could inform analysis in relation to the way in which the participant was interacting with people, objects and the environment. The level of task support received by the participant was recorded along with any events, such as interruptions or particular successes, which may have contributed to the outcome of the research. These can then be considered alongside the general opinions of professionals to determine if any changes can be seen in the ability or behaviours of participants.

The development of the coding structure resulted from pair coding by the researcher and Natalie (a primary school teacher), who had previously been involved in the research during the formative evaluation stage. The first part of the procedure involved the researcher watching all videos. Summary notes were made and interesting points were highlighted. These were constructed into an initial coding schema. Six videos (three for each participant) of varying lengths and that showed a variety of behaviours and interactions were selected to form the sample on which the coding schema was refined.

This subset of six videos was watched together by the researcher and Natalie to aid the refinement of the coding schema until both parties were agreed as to the categories and

definitions to be used. The resulting schema is shown below in table 14, and reflects coding systems used in similar projects including Echoes and STANDUP (Waller et al., 2009).

Table 14: Coding schema

Verbal Hint	The child is given a verbal suggestion, e.g. “What will we do with this brick?”
Verbal Direction	The child is given an instruction, e.g. “Move this brick into this pile”.
Model Action	An adult moves the brick to show what should happen
Physical Support	The child is physically supported in their interaction, e.g. hand-on-hand.
Action Completed	The support person completes the action required in order to proceed.
Peer Direction	The peer directs the child.
Encouragement	The peer, support person or character gives the child encouragement. This might be before, during or after their interaction with the software.
Interruption	The session is interrupted by someone entering the room or by the participant leaving for any reason, e.g. toilet.
Technology Breakdown	When use of the system is stopped due to malfunction of the hardware or software.

Child Interacts with the Software	The child touches the screen with the intention of interacting with the software. This should be coded whether or not the interaction leads to a successful outcome.
Child Interacts with Others	The child interacts with other people in the room, showing clear communicative intent.
Child Vocalises	The child vocalises, with no apparent communicative intent.

9.5.3. Coding

The researcher, Natalie and Margaret, independently coded all videos (n=30), comprising 349 instances. While Natalie had previously been involved in the research, Margaret's involvement began at this point. She has experience of working with children with Autism Spectrum Conditions, but was not familiar with the participants or software.

The participants were provided with the videos on a password-protected hard drive, along with printouts of each transcript (anonymised) and a copy of the coding schema. The transcripts were provided in a table format, with the instance shown in the left-hand column and a space on the right for the code to be written. An example is shown below in table 15.

Table 15: Excerpt from transcript

	Code
……	
CH moves one brick right, bubbles appear	
CH: soft play?	
SLA: this first	
CH sits down, vocalisation, video ends	
……	

9.5.4. Inter-rater reliability of coding

Undertaking inter-rater reliability analysis ensured the consistency of the coding schema and the accuracy of its application by different coders. Three individual coders coded each video.

The agreement statistics used were Cohen's Kappa (Landis and Koch, 1977, Cohen, 1960, Viera and Garrett, 2005) and Fleiss's Kappa (Fleiss, 1971), which calculate the proportional agreement based on the agreement that would be expected by chance. The value of Kappa ranges between 0 and 1. Fleiss's Kappa calculates the agreement between all coders, whereas only two coders are compared to calculate the Cohen's Kappa value. A greater value indicates a greater agreement between coders. A value of 0.61-0.80 indicates a substantial agreement, while a value >0.80 indicates almost perfect agreement.

The inter-rater reliability for all coders using Fleiss's Kappa was calculated to be Kappa = 0.83. Individually, the reliability between the researcher and Natalie was Kappa = 0.848

($p<0.001$), 95% CI (0.806, 0.890). Between the researcher and Margaret this was Kappa = 0.866 ($p<0.001$), 95% CI (0.826, 0.906). Finally, the agreement between Margaret and Natalie was Kappa = 0.776 ($p<0.001$), 95% CI (0.727, 0.825). It can be inferred from these values that the reliability of the coding schema was high and that it was applied consistently and accurately.

Table 16: Video coding: Cohen's Kappa for researcher and Natalie

	Value	Std. Error	% of agreement
Kappa	0.848	0.0213	87.68%
No of items coded	349		

Table 17: Video coding: Cohen's Kappa for researcher and Margaret

	Value	Std. Error	% of agreement
Kappa	0.866	0.0203	89.11%
No of items coded	349		

Table 18: Video coding: Cohen's Kappa for Natalie and Margaret

	Value	Std. Error	% of agreement
Kappa	0.776	0.0249	81.66%
No of items coded	349		

9.5.5. Assessment of overall engagement

In addition to coding the recorded videos, coders were asked to indicate their overall impression of the participant in the videos. In particular they were asked to rate the level of

engagement achieved by the child as well as the level of non-task support seen. The purpose of this was to investigate the qualitative differences in each participant throughout their involvement in the study. Practitioners identified these areas during the design phase (and prior to commencement of the study) as being particularly relevant to the child's engagement with a task. This reflected their observations and experience in the classroom and therapy.

Overall engagement in session videos

After coding the transcription for each video, the coder completed a short questionnaire. This comprised 4 questions with a Likert scale to indicate a response. The questions used and the associated Likert scales are available in Appendix E and focus on 4 areas:

i. Quality of sharing behaviours
ii. Support to use the screen
iii. Challenging behaviours
iv. Support for self-regulation

Four videos were excluded from this analysis as the child participant did not appear on camera or interact with others. A total of 104 responses were collected from each individual coder.

Overall engagement in baseline ad completion videos

Similar summary values were used to qualitatively code the baseline and final videos of the children playing 'Pop-Up-Pirates', as seen in Appendix F and focus on three areas:

i. Quality of sharing behaviours
ii. Challenging behaviours
iii. Support for self-regulation

Coders were asked to indicate the quality of the interactions that were seen in the videos, as well as the level of challenging behaviour and self-regulation seen. Since only two participants were involved, a much smaller number of 12 responses were collected from each coder. In addition to answering the Likert scale questions, coders were also asked to select particular sections of the video that they feel were most relevant and provide comment.

9.5.6. Inter-rater reliability of overall engagement

Again, inter-rater reliability analysis was conducted to ensure consistency between different coders. Three individual coders provided summary values for each video. The agreement statistics used were Cohen's Kappa (Landis and Koch, 1977, Cohen, 1960, Viera and Garrett, 2005) and Fleiss's Kappa (Fleiss, 1971), providing values ranging from 0-1.

Summary values for sessions with the sharing system

The inter-rater reliability for all coders using Fleiss's Kappa was calculated to be Kappa = 0.759. Individually, the reliability between the researcher and Natalie was Kappa = 0.774 ($p<0.001$), 95% CI (0.673, 0.874). Between the researcher and Margaret this was Kappa = 0.803 ($p<0.001$), 95% CI (0.705, 0.900). Finally, the agreement between Margaret and Natalie was Kappa = 0.700 ($p<0.001$), 95% CI (0.587, 0.812). While these values are less than those calculated for the coded transcripts, they are at mostly within the range of 0.61-0.80, which indicates substantial agreement. The Cohen's Kappa value of Kappa = 0.803 between the researcher and Margaret is greater than 0.80 and so indicates an almost perfect agreement between the coders.

Table 19: Overall engagement: Cohen's Kappa for researcher and Natalie

	Value	Std. Error	% of agreement
Kappa	0.774	0.0514	85.58%
No of items coded	104		

Table 20: Overall engagement: Cohen's Kappa for researcher and Margaret

	Value	Std. Error	% of agreement
Kappa	0.803	0.0498	87.5%
No of items coded	104		

Table 21: Overall engagement: Cohen's Kappa for Natalie and Margaret

	Value	Std. Error	% of agreement
Kappa	0.700	0.0498	80.77%
No of items coded	104		

Summary values for baseline sessions

The inter-rater reliability for all coders using Fleiss's Kappa was calculated to be Kappa = 0.508. This is within the range of substantial agreement. Individually, the reliability between the researcher and Natalie was Kappa = 0.625 ($p<0.001$), 95% CI (0.283, 0.967). Between the researcher and Margaret this was Kappa = 0.520 ($p<0.001$), 95% CI (0.188, 0.852). Finally, the agreement between Margaret and Natalie was Kappa = 0.4 ($p<0.001$), 95% CI (0.0336, 0.766).

Table 22: Baseline sessions: Cohen's Kappa for researcher and Natalie

	Value	Std. Error	% of agreement
Kappa	0.625	0.174	75%
No of items coded	12		

Table 23: Baseline sessions: Cohen's Kappa for researcher and Margaret

	Value	Std. Error	% of agreement
Kappa	0.520	0.169	66.67%
No of items coded	12		

Table 24: Baseline sessions: Cohen's Kappa for Natalie and Margaret

	Value	Std. Error	% of agreement
Kappa	0.4	0.187	58.3%
No of items coded	12		

These values are considerably less than other reliability statistics calculated and have large confidence intervals, but show mainly substantial agreement. Agreement between the researcher and the respective coders is substantial, but the agreement between Natalie and Margaret is within the range of 0.41-0.6 showing moderate agreement. However, there were only 12 items coded which were extremely subjective and the overall agreement of the Fleiss's Kappa is within the range of substantial agreement.

9.6 Results

9.6.1. Social validity

Four social validity questionnaires were completed. The calculated values of the completed questionnaires ranged from 33-39 with a mean of 35.25. The authors of the test (Kelley et al., 1989) have indicated that a score of 27 shows a moderate acceptance of the intervention, with a maximum possible score being 40.

It can therefore be concluded that the intervention has a high level of social validity, which would typically correlate with successful outcomes for participants.

9.6.2. Summary of session video coding

Over the sessions interacting with the sharing tool, a total of 349 instances were coded and the categories applied from the coding schema are summarised in the table below. The values shown are mean values attributed by the coders across each category and serve to illustrate the differences in the interaction of participants during the sessions.

Table 25: Summary of the application of the coding schema

Coding Category	Chris	Craig	TOTAL
Verbal Hint	9	14	**23**
Verbal Direction	20	74	**94**
Model Action	4	18	**22**
Physical Support	0	9	**9**
Action Completed	2	6	**8**
Peer Direction	0	7	**7**
Encouragement	10	41	**51**
Interruption	1	2	**3**
Technology Breakdown	2	8	**10**
Child Interacts with the Software	46	52	**98**
Child Interacts with Others	11	3	**14**
Child Vocalises	7	3	**10**
			347

Across the two participants there was similar levels of interaction with the sharing tool (Chris = 46, Craig = 52), but Craig had a much greater number of instances of being given verbal direction by the researcher or support person (n=74 compared to n=20). Both participants experiences similar and minimal levels of interruptions, with Craig experiencing more instances of technology breakdown. Finally, Chris appears to have interacted more with others and had a greater number of instances of vocalisation.

The trends seen across time were also considered. Chris interacted more with the software as time went on. To begin with, he had considerable verbal direction but this decreased as he progressed through the sessions. During initial sessions he frequently interacted with others,

but this interaction decreased in the later stages of the study. Similarly, encouragement was more frequent in earlier sessions. He was never given direction from a peer, but he did vocalise more during sessions with a peer, which was showing a decreasing trend until this point. No instances of Chris receiving physical support were recorded.

In the data pertaining to Craig, there was a decreasing trend in direction from adults and clear peer direction was coded during peer sessions. As time progressed, there was a decrease in the amount of encouragement received as well as a decrease in the number of instances coded as interacting with others and vocalising. Finally, there was a decrease across time in the number of times the researcher had to complete an action in order to proceed through the session.

9.6.3. Assessment of overall engagement in session videos

All three coders completed questionnaires consisting of Likert scales after watching each video of a sharing session. For each student, the mean value was plotted in relation to each sharing session. Full descriptions of the Likert scales used can be found in appendix E.

The first of these is the quality of sharing behaviours the child was considered to have achieved in their interaction with the sharing system (Figure 37). A value of zero indicates no success, while a value of three indicates complete success. The data for Chris appears to have less variation and is scoring consistently higher towards the latter sessions. However, he does not score above 2, which indicates that he has displayed sharing behaviours but does not appear to understand the social application of these skills. There are two points of interest (sessions five and ten) which are discussed later. Craig also appears to show an

increased quality of sharing towards the end of the sessions, with more of his highest scoring values appearing in the latter stages.

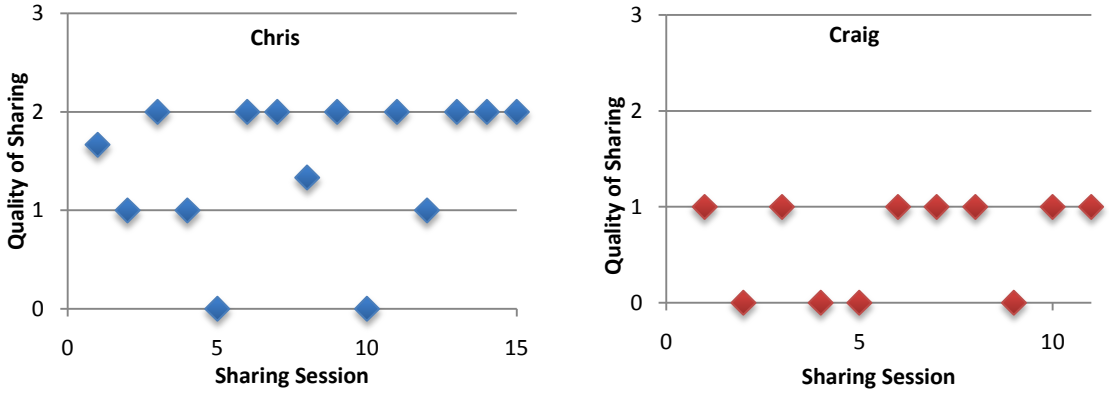


Figure 37: Sharing videos: quality of sharing

The second is the level of support required to use the screen (Figure 38). A value of zero indicates that no support was required and a value of three inidicates that the child was dependent on support to use the screen. Chris scores consistently low on this scale indicating that he typically requires no support to use the screen. On the other hand, Craig appears to have much more variance, requiring different levels of support during each session.

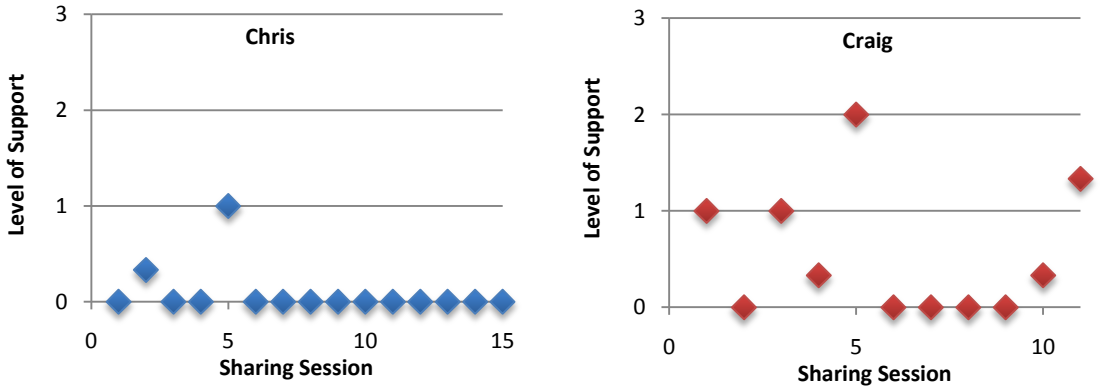


Figure 38: Sharing videos: level of support required to use the screen

The level of challenging behaviour shown by the child is also considered (Figure 39). A value of zero indicates no challenging behaviours and a value of two indicates major challenging behaviours. The two participants appear to display opposing trends in this case. It can be seen that for Chris, his challenging behaviour was greatest at the beginning of the session, but was reduced in the later stages of the study. Again, session ten is of interest, as this session appears to deviate from a settled trend of no challenging behaviours. Craig, however, begins the study displaying no challenging behaviours and at the end of the study is noted as displaying some challenging behaviours.

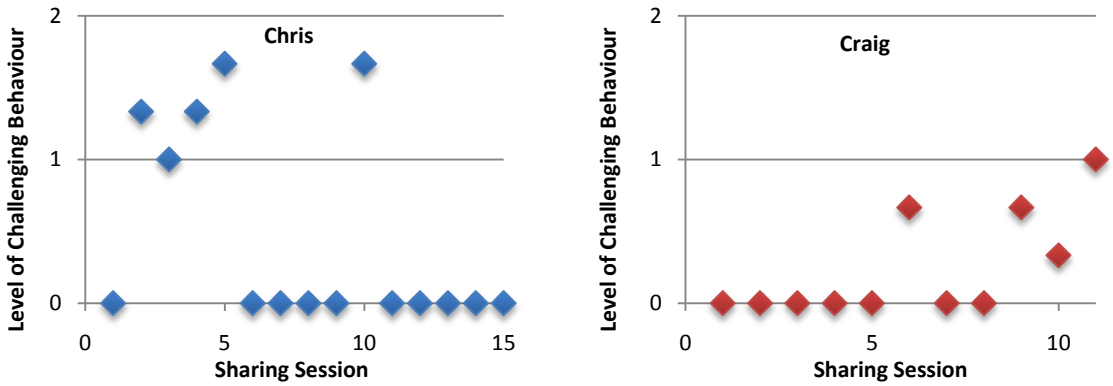


Figure 39: Sharing videos: level of challenging behaviours

The final area of consideration was the ability of the child to self-regulate (Figure 40). A value of zero indicates that the child was able to self-regulate with no support, while a value of three indicates that the child was dependent on support. The data for this assessment value is much more varied than previous assessment scores. The data for Chris shows earlier values rated highly, with later values being at the lower end of the scale. The data for Craig shows a cluster of higher rated values in the latter sessions, indicating a need for support in order to self-regulate.

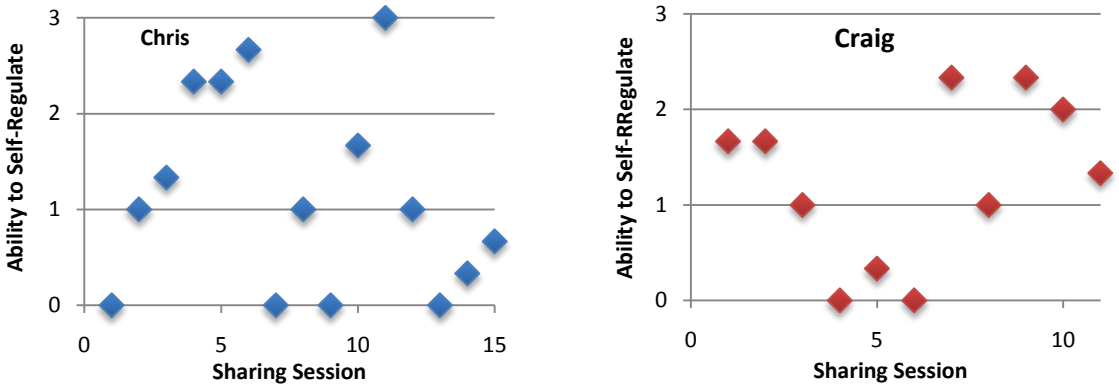


Figure 40: Sharing videos: level of support required for self-regulation

9.6.4. Assessment of overall engagement in baseline and completion assessment videos

All three coders completed questionnaires consisting of Likert scales after watching each assessment video. For each student, the mean value was plotted in relation to each sharing session. Full descriptions of the Likert scales used can be found in appendix F.

The first of these is the quality of sharing behaviours the child was considered to have achieved in their interactions (Figure 41). A value of zero indicates no success, while a value of three indicates complete success. Both participants have shown higher quality in their sharing interactions after having used the sharing tool than in the baseline session before.

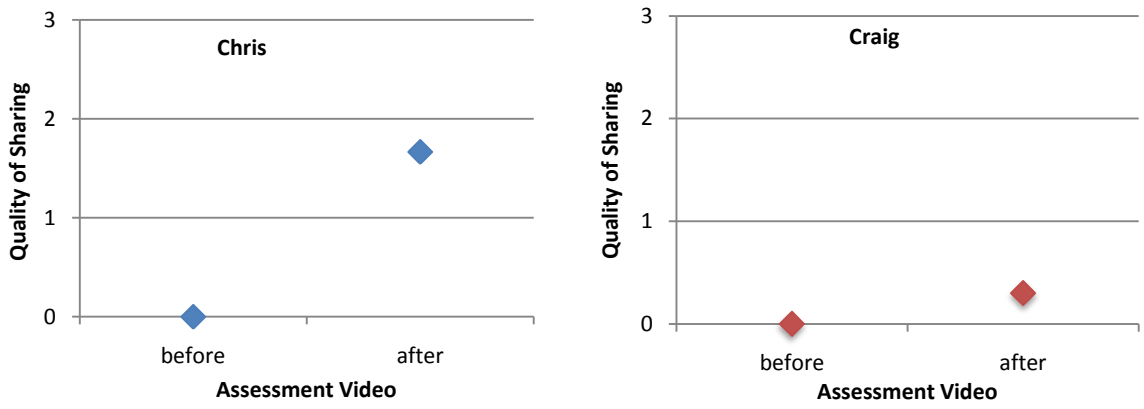


Figure 41: Assessment videos: quality of sharing

The level of challenging behaviour shown by the child is also considered (Figure 42). A value of zero indicates no challenging behaviours and a value of two indicates major challenging behaviours. The level of Chris's challenging behaviour has been scored by coders as being lesser after using the sharing tool than before. Craig showed no change, with no challenging behaviours before or after the sharing tool sessions.

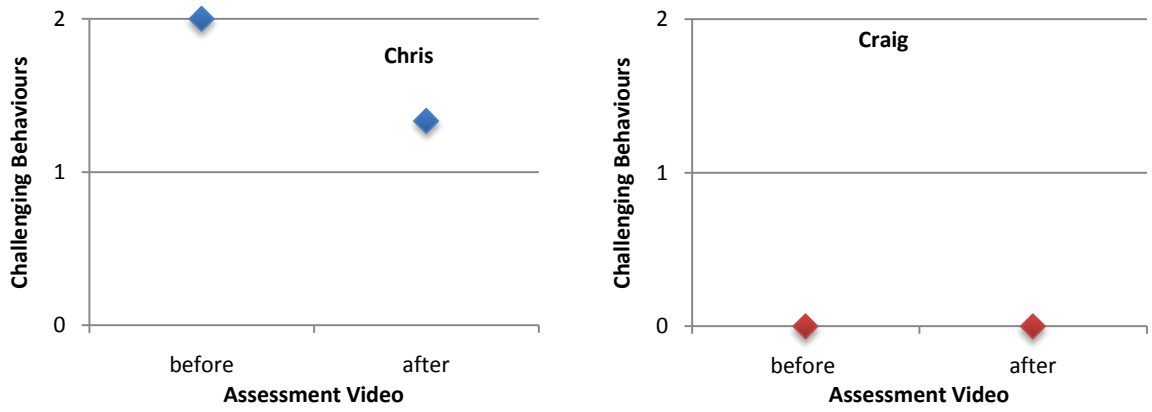


Figure 42: Assessment videos: level of challenging behaviours

The final area of consideration was the ability of the child to self-regulate (Figure 43). A value of zero indicates that the child was able to self-regulate with no support, while a value of three indicates that the child was dependent on support. It can be seen that the data for Chris shows a decrease in the support required to self-regulate, whereas Craig appears to have an increased need for support after the sharing sessions.

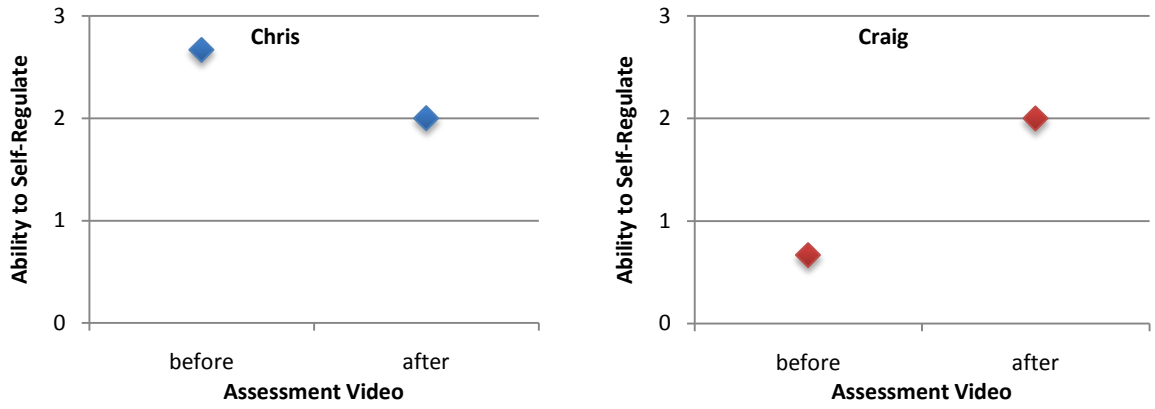


Figure 43: Assessment videos: level of support required for self-regulation

9.7 Discussion

9.7.1. Practitioner involvement

Practitioners were heavily involved in the methodological design of this study. The classroom staff in particular provided much valuable time to ensuring that the researcher was comfortable in working closely with the two participants, giving instruction and advice in how to communicate and interact with them in order to create the best environment for their individual learning needs. This time was often their own personal time such as lunch breaks, showing their motivation to be involved in the study.

On occasion, the practitioners did disagree, but this was often to the benefit of both the study and the classroom environment. For example, concerning Craig, he regularly exhibits rocking behaviours, but he will cease this activity if instructed to do so. This often occurs during class time when he becomes engrossed in this rocking behaviour to the neglect of his current task, and is a current focus of the staff. During discussion with practitioners regarding this there was disagreement, as one individual felt that this behaviour was likely to impede his ability to complete the task, while another felt that he may use this behaviour to

avoid the task and yet another felt that he would use the behaviour as a self-regulatory behaviour when faced with the new task. It was therefore decided that the researcher would discourage any rocking behaviour as they occurred but would fall short of instructing Chris, e.g. “rocking is finished”. This would be left to the member of school staff present who would make an assessment based on other factors external to the project, such as previous classroom activities or incidents. This varied insight was critical to the success of the research as it allowed the researcher a more full understanding of the participant’s behaviours and motivations.

The practitioner involvement in selecting appropriate measures of success was also important. The final measures chosen (quality of sharing, support to use the screen, challenging behaviours and support for self-regulation) arose from continual discussion and refinement of success indicators used in the classroom. In addition, these are closely related to the individual learning goals of each child participant, and so will have a use for the school staff as well as the researcher. This suggests that the results will have a clear impact and practical application in terms of influencing the education and learning goals of individual participants.

9.7.2. Chris

Of the two participants, Chris appears to have shown most progress between the baseline and final assessment videos. The perceived quality of sharing appears to show an increase. However, while he has the ability to exhibit sharing behaviours such as the division of objects, he has yet to show any social understanding of these skills. The final assessment video shows Chris taking turns with his social partner (Craig) and sharing the game appropriately. Notwithstanding this apparent success, there were no clear social behaviours

with clear communicative intent, such as making eye contact or verbal utterances. It was noted by the teacher (Yasmin) observing the session that Chris appears to have the skill to share the game with his social partner, but not with social intent. She proposed that Chris now requires specific learning goals related to initiating play with others in order to develop his skills further.

The perceived quality of sharing from the session videos appears to show this ceiling effect, whereby Chris has understood the principle of dividing the objects but needs further instruction to understand the social functions of the skill. He consistently scored within the "success, but no social understanding" category of this measure, particularly towards the end of the study. The intentions of his behaviours in this respect can be further examined, with Chris clearly repeating the behaviour required for sharing, but showing no apparent social desire or intent in his behaviours. This is a commonly reported phenomenon in autism spectrum conditions: the repetition of learned behaviours. The action of repeating the behaviours is a conscious one (Pizant et al, 2008a), and so some intentionality can be attributed to Chris's actions. It is wholly possible that the purpose of such behaviours has a social basis, but this is not clearly seen due to the confounding social difficulties. Further investigation with human communication partners will be needed to assess Chris's sharing skills before intentionality can be accurately attributed.

However, the repetition of behaviours has a number of implications outwith the scope of this research study. By repeating the learned behaviour, the skill is developed, and so the application of that skill may be forthcoming. Repeating behaviours over a period of time can be reassuring for individuals with autism spectrum conditions and can allow for the regulation of emotional distress. While it is generally purported that a decline in repetitive behaviours shows a decrease in emotional distress and anxiety, it is equally possible that a

consistent maintenance and even an increase in repetitive behaviours can result from decreasing anxiety. The evidence for the latter case is strengthened by the observation that repetitive sharing behaviours are shown to increase while the incidence of challenging behaviours decreases (challenging behaviours is a sign that Chris is experiencing anxiety). Thus, it can be suggested that Chris is engaging in these repetitive sharing behaviours because his anxiety levels are decreasing and he is comfortable engaging with the system. This has a positive bearing on the potential for future social successes.

In sharing session 14, the only indication of Chris's social understanding was seen. Chris has a particular dislike of one individual in his class. Following previous discussion with the support for learning assistant (Heather), it was noted that Chris did not appear to be looking at the images of people; rather he was focussed on the bricks and moving them around the screen. During the subsequent sharing activity, the static image of the researcher was replaced with one of the aforementioned classmate. Chris immediately covered the 'offending' image with his hand and uttered "Goodbye!" Thus it was clear that Chris *was* looking at the images.

Practitioners assessed Chris in sessions 5 and 10 as displaying no sharing behaviours. This correlates with a high level of challenging behaviours across both sessions. During session 5, Chris found it difficult to use the screen and became frustrated. After banging on the screen, Chris simply wandered away to the other side of the room before pushing his way out of the room. In session 10, Chris refused to participate in the activity. During this session, a peer was introduced for the first time, which may explain his refusal. He was, however, encouraged to participate in later sessions although he did not directly interact with the peer. Over time the levels of challenging behaviour shown by Chris decreased. This was at odds with the classroom situation, where Chris became increasingly unsettled, most likely

due to the impending summer holidays and changes to his schedule such as sports day and end of year assemblies.

Chris was motivated to engage with the sharing tool in a way that he did not engage with typical classroom activities. The motivation was the bubble activities, with Chris requesting the bubbles activity before commencing the sharing scenario. Observations by the researcher and support person were that Chris was highly motivated by the bubble popping activity and was rarely distracted during it. His sharing actions appear to be solely in order to achieve something desirable, i.e. bubble popping. Plans are in place to exploit this motivation by creating an iPad application that allows bubble popping for a set time after completing classroom tasks and activities. Currently, Chris visits a soft-play room to assist his emotional self-regulation, but it is hoped that the bubble-popping application will allow self-regulation within the classroom. The principal motivation for Chris was the number of bubbles he popped (displayed on the bottom left of the screen). During one session, the researcher rested a hand in this portion of the screen, triggering Chris to physically move the hand. He did not use eye gaze or speech to initiate communication, which attests to the people-object consideration of Autism Spectrum Conditions (Prizant et al., 2006). This gave rise to a teaching objective – How to ask someone to move by saying "Excuse me". In this case, the carry-over from the study was not a generalised behaviour, but a learning objective uncovered with a clear purpose and application. This has been considered as a learning objective for Chris for the following school year.

Coders, the researchers and support persons have noted that Chris displays an auditory sensitivity. This was previously seen during the Echoes evaluations. Whenever the character on-screen spoke, he covered his ears and vocalised, presumably to drown out the sound. However, this means that Chris is likely to miss social cues, such as pointing, to assist him

in completing the task. This could account for the greater number of instances of verbal instruction being given during earlier sessions as the researcher repeated the instructions given by the on-screen character. By providing further verbal instructions, the researcher has replaced these missed social cues with a format more easily understood by Chris. This makes it clear that software designed for individuals with ASC should include a customisation option for preferred modalities, or at least make use of multiple modalities. Ideally this would be in an intelligent manner, such that if the user does not respond to a given request or piece of information, this can be provided in an alternative and accessible format.

In summary, work conducted with Chris during this study has resulted in a clear carry-over of some aspects from the research setting to the classroom environment. The most prominent of these is his ability to self-regulate during bubble-popping activities, which are particularly motivating. In addition, specific learning objectives were identified for inclusion in future teaching and learning goals setting.

9.7.3. Craig

Chris has shown some improvement over the course of the study, but this has been very minimal. He showed no challenging behaviour in either of the two assessment videos but has become less able to self-regulate.

This increase in support required for self-regulation was shown across the sharing sessions. In addition the level of challenging behaviour increases over time. Notes in the research diary show that Craig displayed these behaviours in the classroom also. He was very unsettled and had lost interest in school activities, becoming disengaged. He was content to sit alone, spinning a ball; this behaviour was increasingly prevalent towards the end of the

study. This disengagement was typical of Craig's behaviour toward the end of the school year as he tired of school. Since the end of the study coincided with the end of the school year, this made engagement with the research activities difficult.

The last three sessions (9, 10, 11) occurred on the same day and showed repeated attempts by the researcher and school staff to engage Craig. This included a reward of playing with wool, which he had brought from home and left in the classroom before the session. During these sessions it can be seen that he has begun to display challenging behaviours that were not previously demonstrated. While these behaviours were classified as being minor, they were a departure from his usual character. Since these behaviours occurred at the end of the study, it is not clear whether these are continued. School staff did note, however, that these disengaged behaviours continued until the end of term, and they found it difficult to prepare Craig for the changes that the holidays would make to his daily schedule.

As time progressed from the beginning of the study, Craig became more proficient in using the screen and moving the bricks around, although not always demonstrating appropriate sharing skills. The acquisition of these skills is correlated with a decrease in direction from adults and vocalisation, which is typically employed by Craig as a method of catching someone's attention. This decrease in interaction may be that Craig was responding to directions given in a social manner, even if these intentions were not immediately clear on observation.

Craig was also highly responsive to applause, which was an excellent motivator for him. He enjoyed the applause played at the end of using the sharing tool but this was a delayed reward and he became distracted before the tool reached this point. A decision was then taken to change the applause sound to when then a brick was moved to an appropriate pile. At this point, Craig did not show any social understanding of sharing but was motivated to

use the system. As a result he remained engaged with the bubble-popping scenario and was much more animated at this stage than previously. He was particularly pleased when the smiley face was displayed and he repeated the applause by touching the face. He then verbally initiated further activities by taking the researcher's hand and then asking "bubbles please". This shows the greatly increased motivation to use the system. Later in the study, applause was still used to engage him when necessary.

Yasmin harnessed the power of the applause as a motivator in classroom situations. Craig often became disengaged when completing repetitive tasks such as maths sums. To encourage his participation, the applause was recorded onto a BIGmack communicator (see figure 44). This was used to encourage Craig to complete tasks, such as "five sums then press it" or "tidy up then clapping". Craig also participated in the Echoes project when it was clear that he responded well and recognised his success when praise was excessive and animated.

Figure 44: The BIGmack Communicator used for the applause sound

Craig's engagement with peers was also of interest and has highlighted the need for a nurturing environment, specific to the needs of the individual. During the time period of peer

sessions, Chris was particularly noisy and moved around the room a lot. This tended to intimidate Craig and was noted by classroom staff as occurring throughout the day. At the beginning of the study this was not considered to be an issue, but Chris's behaviour had deteriorated within the school. Working with Kevin was also problematic as, even though he is non-verbal, he is noisy and animated which, again, Craig appeared to find intimidating. This was also the opinion of the school staff. Alison, however, was much more protective and caring towards Craig, which meant that he was much calmer. Alison offered guidance to Craig including physical assistance and encouraging him to move the bricks to the correct place.

In summary, it was difficult to engage Chris in the sharing tool activities, but this was an issue throughout the school environment. He interacted well with calmer peers but did not engage with Chris or Kevin as they intimidated him. In terms of carry-over, the use of applause as a motivator was considered within the classroom to engage Craig in repetitive tasks he may find it difficult to engage with. It can also be used to reinforce his successes.

9.8 Summary

Two male participants with Autism Spectrum Conditions, aged 14 years, used the sharing tool over a period of five weeks. Video data was gathered and analysed with direct practitioner involvement. This analysis evaluated the impact of the system on the participants' sharing abilities and their social understanding of sharing behaviours.

An improvement was shown in the participants' sharing behaviours after using the sharing tool. In addition, knowledge was gained by practitioners during the study whoch was transferred to the wider social context. This knowledge includes specific motivations for

individual participants which can be made use of within the classroom and wider settings to promote engagement in educational tasks and social interactions. Furthermore, a number of learning goals were uncovered that will be addressed within the school environment in the coming academic year.

Chapter 10. **Conclusions**

This chapter begins by summarising the work conducted in this thesis. Subsequently, each research question is addressed and the conclusions of the PhD research are identified.

10.1 Overview of research

This research has investigated the benefits of participatory design methodologies in including a variety of stakeholders in the design of a technology-enhanced learning system. The focus is on the inclusion of children with Autism Spectrum Conditions and practitioners in adapted design methodologies. The purpose of the resultant technology was to improve social skills, specifically sharing in children with Autism Spectrum Conditions.

Practitioners and children, both with Autism Spectrum Conditions and without, were involved in the development of the system interface and interaction. This involvement included observations, interviews and design workshops, and resulted in the creation of a series of low and high fidelity prototypes. Involvement was considered in terms of the overall contribution and the benefits to each group of their participation. With the final design implemented, two children with Autism Spectrum Conditions used the system alongside their usual educational activities over a period of five weeks. Video data was gathered, transcribed and coded by the researcher and teachers. The sessions were coded using a scheme developed to code interactions, and were assessed with respect to the quality of sharing displayed, support required to use the screen, challenging behaviours and the support required for self-regulation. This data was then analysed to evaluate the impact of the system on their ability and understanding of sharing behaviours using a case study methodology.

Subsequent analysis showed an improvement, albeit minimal, on sharing behaviours after using the sharing tool. Knowledge was gained during the study for transfer to a wider social context, including motivations (such as applause) that were transferred to the classroom to enhance engagement in educational tasks. Finally, a number of learning goals were also uncovered for both participants that will be addressed within the school environment in the coming school year.

Through the implementation of the sharing tool within the educational environment, practitioners were afforded opportunities to observe the participants using the system and to reflect on the behaviours, successes and challenges of participants. This reflection, along with the knowledge and experience of practitioners has resulted in multiple and innovative improvements to the learning environment for participants. Combined with the above noted identification of specific learning goals, the educational environment has been transformed to better meet the varied and specific needs of individual participants.

10.2 Outcomes of research

10.2.1. **Improving sharing through the use of a computer-based tool**

> *Can social skills, in particular sharing, be improved in ASC through the use of a computer-based tool designed specifically to support this?*

Sharing skills appear to have improved, but the short duration of the project means that limited data was gathered to support this claim. Qualitative observations indicate that the participants have understood the principle of dividing objects between people and sharing the objects, but that this is understood as a means to an end, i.e. completion of the sharing session will result in a desirable outcome for the child. Neither participant shows clear social or communicative intent while sharing, and their behaviour appears to display a ceiling

effect. This repetition of behaviours is a common occurrence in individuals with Autism Spectrum Conditions, and if the child is comfortable enough to use the software for emotional regulation in this way, then some measure of success can be attributed. While this success is not typical in the desired display of social behaviours it should not be discounted. The interpretation of this behaviour is crucial, as it should not be discounted. Repetitive behaviours are intentional and so can contribute to a contextual understanding of the use of the sharing tool. In summary, the child has achieved a satisfactory outcome to complete the sharing sessions using the software, but requires further tuition to transfer these skills to the realm of social interaction and communication.

10.2.2. **Generalising sharing skills**

> *Do any improvements, i.e. in knowledge or skills, carry through to a wider social context?*

The sharing skills shown by the participants in the baseline and final assessment videos show some improvement, but it can be debated whether this improvement is a result of intensive tutoring by the researcher and school staff, or of working with the sharing tool. The argument for the introduction of the research is mediated, in part, as the researcher was familiar to the child and had worked with them previously as part of a research study.

No specific sharing skills have carried through to a wider context; rather the practitioners have analysed and understood behaviours displayed by the participants and have made changes to their learning environment, such that new skills may come to the fore. For example, work conducted with Chris during the study has identified two learning goals for the coming academic year. Firstly, he will be encouraged to appropriately initiate play with others and also to ask others to move from in front of him, rather than simply moving them

out of his way. His motivation for the bubble popping activity was also strongly observed. Plans have been made to exploit this as a means of self-regulation and within a reward structure, with the creation of an iPad app that can be used in multiple locations. Motivation as a means of engagement has been prevalent across both participants, with Craig showing high levels of motivation for the sound of applause. This has been observed within the classroom also using excessive praise, and the sound of applause has been recorded on a BIGmack Communicator button to supplement and further develop this.

Thus the sharing tool has been a vehicle for change within classrooms by allowing practitioners opportunities to reflect on the behaviours of participants and to make use of this new knowledge to improve the learning environment in multiple and innovative ways. This reinforces the benefit of practitioner involvement in the study, which has led to successful outcomes, despite no sharing skills being generalised.

10.2.3. **Participation of children with ASC in the design process**

How can children with ASC participate in the design process and what are potential outcomes of this?

Children with a range of Autism Spectrum Conditions participated in the design of the system through the initial exploratory studies to the formative evaluation stage. The level of involvement has varied. Issues concerned with Theory of Mind difficulties and a lack of imagination have thus far been a barrier to the involvement of children with Autism Spectrum Conditions in the design process. However, methodologies have been considered with careful attention to sensory issues and the need for structure in order to promote engagement with tasks. Having tasks the children are familiar with, such as drawing or craft activities has been useful. Also useful was the presence of a parent or other familiar adult to

provide reassurance. In some cases, this was successful and resulted in the identification or adaptation of some requirements; in others there was not as much direct impact on the design as one might have hoped. This serves to confirm the literature, while having some success in influencing the direction of this research.

In addition to design activities, the observed behaviours of children with Autism Spectrum Conditions and the inferences made from these by experienced professionals are invaluable to the design process. Children with Autism Spectrum Conditions have not been involved in the design of the system further than as a design informant since they are (for the most part) unable to imagine situations outwith their experiences and to avoid any undue pressure or design responsibility. Despite this limit, their involvement has been crucial in giving them a voice in the design process and ensuring that researchers and designers are as informed as possible about Autism Spectrum Conditions and the practical implications that this may have on software interaction. Even though the involvement of children with Autism Spectrum Conditions does not obviously produce solutions such as clear interface designs or coherent descriptions of sharing, the value of involving this user group is having opportunities for observation, with the analysis and inferences of practitioners being an invaluable aspect of this. The behaviours of children with Autism Spectrum Conditions, while seeming random and without purpose to an untrained eye, can unfold an infinite wealth of information when viewed by individuals who are trained and experienced in interacting with this user group.

Involvement in formative studies is extremely useful for evaluating the design, but this has been seen only in high-tech prototypes or at the usability-testing phase (thus not involving imagination to visualise the finished system). Children with Autism Spectrum Conditions were able to suggest changes or indicate when an aspect of the system is unclear (e.g. Lego

bricks disappearing when they are moved – “where did they go?”), which shows that they can have direct impact on the design of computer software when provided with the correct tools and environment. The children involved at this stage were higher functioning than the children involved as case studies, and so provided much more obvious cues in their interactions. This does not mean that children with more severe Autism Spectrum Conditions would not have been able to contribute to similar results, but the process has been streamlined since the results required less inference from practitioners than other studies within the research, such as the discussion group with children with Autism Spectrum Conditions.

There are, however, challenges of working with children with Autism Spectrum Conditions. In order to fully understand the context of use of the system, the researcher must invest considerable time in becoming integrated into the environment, which shows a clear balance between the volume of research which is possible and the quality of the results which can be produced. There are clear ethical and research based benefits to the software development and to the development of evaluation methodologies, but this can be difficult. For example, children may become attached to the presence of the researcher and/or activities that the researcher offers, so it can be difficult to withdraw from the environment when the study is complete. In this case, the study was coincided to finish at the end of term, which alleviated some of these difficulties as the participants were prepared for the absence of the researcher.

10.2.4. **Participation of practitioners**

What can practitioners contribute to the design process and what is the impact of this?

What do practitioners learn through contributing to the research by adding to the design and observing children using the system?

Practitioners can contribute a great deal to the design process through imparting their knowledge to the researcher. This knowledge is gathered often through many years of varied experiences and can be invaluable in determining important aspects of a situation or how to predict outcomes for a child. Through working closely with practitioners, the researcher can learn how to communicate with individual children who may have specific needs. Practitioners are also in a unique position to comment on the developmental appropriateness of a design and to predict outcomes of that design within the participant group. Given the heterogeneous nature of this group, predictions such as these can allow the researcher to prepare for multiple outcomes where appropriate. For example, when showing a piece of software to a child with Autism Spectrum Conditions for the first time, there may be many possible reactions to it, such as engagement, frustration, dislike of certain sounds, etc. Practitioners can become proxy users and offer 'insider information' to ensure that a design attempts to avoid negative outcomes.

For the researcher, working with practitioners is extremely rewarding and informative, but can have challenges which must be met. For example, it can be difficult to manage the expectations of practitioners who may under or over estimate the power of technology or the time period in which it can be developed. They may also be reluctant to push the boundaries in terms of technology, particularly if they are not confident in using it themselves. In addition, time is a precious commodity for practitioners and researchers must be careful not to over-use this time. Being efficient, encouraging and, most importantly, understanding of

these challenges will ensure that practitioners understand their value within the project. Finally, many practitioners can be reluctant to criticise the work of their peers due to professional courtesy. This was reduced when working on a one-to-one basis with practitioners rather than as a focus group format.

Practitioners can learn a great deal from being involved in research such as this. For some, this might be the only time they are able to meet other like-minded practitioners and focus on areas outwith their typical day-to-day role. This sharing of ideas can be useful as it allows practitioners to hear suggestions and actions that they may make use of in their own role later. One practitioner commented, *"I always go away from these meetings with more information than I came with. My brain is filled with all these new ideas"*. For some practitioners, involvement in such studies can count towards their Continuing Professional Development, particularly for those at management level.

10.3 Working in a school environment

Working within a school environment is crucial in order to fully understand the context of use of any software system and to fully appreciate the potential actions and behaviours of the participant group (Pole and Morrison, 2003). Undertaking work within this area can be challenging and time consuming, but ultimately rewarding both personally and within a research project. The process of building effective working relationships with schools can require a great deal of time. The most effective relationships are those which are synergistic: both parties (i.e. the research establishment and the school) contribute to the relation with both parties gaining from the relationship more than they are capable of as a stand-alone institution. This is particularly true for complex user research such as that contained in this thesis. The intricate nature of the user studies is such that schools have neither the resources

nor knowledge base to complete them independently, and may need to network of the researcher to disseminate results in the appropriate channels. In a similar vein, the researchers must access participants within the educational environment in order to fully complete the work, ensuring that the naturalistic environment is considered in the research. Only when both parties contribute in this way, can the resulting research be meaningful and beneficial to both the educational sector and the research institution. By bridging the gap between research and education, a productive and consequential relationship can be developed, which gives rise to effective solutions for real-world problems.

When working within another organisation, the research must adhere to local and contextually specific codes of practice. This includes ethical procedures. Despite having ethical clearance, from the research organisation, ethical approval must be sought from the local council. Also, space within a school may be at a premium. In this project, a room was shared with other services. When note in use, the screen proved a distractor for other children and so where the screen was kept must be decided by both parties. The timetable was also constrained as a result of this shared space, since the researcher could only use the room when the other services where not present. This limited the possible days of use to three or sometime two days per week. However, this was a project success, as many schools are not designed for research collaborations with space being at a minimum. In addition, classroom timetables can provide constraints due to life skills visits to out of school locations and the children within a classroom following individual timetables. This meant that time between participant sessions, for example during the summative evaluation, was limited and so any hand-over before and after sessions was minimal. There was always time later for discussions with the class teacher, but it would be useful to have quick discussion with school staff to fully understand the child on that particular day (i.e. what has been

happening, how they are behaving that day, levels of self-regulation) before they start to use the system. This was minimised by having a member of school staff present during sessions, which can further limit the research timetable.

There is also the issue of how to deal with disengagement as a result of challenging behaviours. This can be seen frequently in this participant group, but the researcher has neither the authority nor the training to reprimand or otherwise attempt to control these behaviours. Thus, a support person who has the relevant authority was always present, particularly if a participant 'meltdown' may result in the need for restraint. This also means that an experienced practitioner will observe research activities, which is advantageous for both researcher feedback and ethical acceptance.

10.4 Future directions

This research has highlighted the potential of the sharing tool to

i. Assist children with Autism Spectrum Conditions to explore sharing skills
ii. Give practitioners opportunities to observe children with Autism Spectrum Conditions with a view to identifying new skills or learning objectives, which can be carried over to other settings.

Additional work is required to further explore the potential of technology in this area and to address some supplementary research ideas that have arisen during evaluation.

10.4.1. **Motivation**

Practitioners first raised the concept of motivation during exploratory studies as being crucial to ensuring engagement with a task. This motivation in the typically developing population may be through social or positive reinforcement, but this is unlikely to be the case in children with Autism Spectrum Conditions, particularly when considering social and communication skills. During the summative evaluations, motivational factors were again observed and were in fact crucial to the engagement of participants with the sharing tool. This motivation was uncovered while observing the child using the sharing tool, but it is proposed that the motivation to use the system is planned in future development cycles, perhaps through the use of customisation. Motivational factors may take many forms, such as colours, sounds or music.

10.4.2. **Customisation**

Customisation can comprise many forms and can be crucial to the engagement of children with the software. During the evaluation, the researcher altered some aspects of the software to better motivate individual participants, e.g. having an applause sound after moving each brick. It is proposed that a suitable adult could customise the sharing tool initially, before the child uses it. This means that one installation can be used for multiple children making it more suitable for a busy and time-constrained educational environment. This customisation could be in the form of a short menu system that allows the selection of, for example, a colour scheme, background image, the character to interact with or bubble size. Some data is already available to begin this process, having been gathered from the What Objects? Design Workshop.

Future customisation can occur at two levels. Firstly, the customisation may be specific to the child, for example, an interface theme or multimodal preferences such as sound or colours. In addition, the customisation may be at the level of the school. This could include the language used in the classroom settings or the type of signing used by the onscreen character to match that currently used in the school.

Future development of this could comprise the implementation of artificial intelligence and learner profiles. This would ensure a continual review of the customisation and thus ensure that the user is facing new learning objectives and goals as necessary.

10.5 Summary

This thesis has resulted in the creation of a software tool that allows children with Autism Spectrum Conditions to explore sharing skills in a structured manner. This is the first software system that has been created specifically for the purpose of exploring sharing skills. There are clear practical applications of sharing skills both within the software and in reality, for learning and independent living. Two participants with Autism Spectrum Conditions used this sharing tool for five weeks. Evaluation showed that the system provides a useful vehicle for exploring sharing skills in children with Autism Spectrum Conditions, with some within-task improvements seen when using the sharing tool for a period of five weeks. In addition, the system has allowed opportunities for children with Autism Spectrum Conditions to explore social behaviours within a safe environment and has resulted in the identification of specific learning needs and learning goals for individual participants. The recognition of these needs and goals has had a direct impact, having been considered and implemented within the wider learning environment.

Practitioners were actively involved in both the design of the software and the subsequent evaluation. Their involvement was varied and included early design interviews, observations and video coding of children with Autism Spectrum Conditions using the sharing tool. This involvement has ensured that the wealth of experience and knowledge within this group has impacted on the design and eventual use of the sharing tool. The software design was grounded in best practice and their input to the evaluation made sure that the measures were relevant to the real-life educational and social goals of participants. The research has allowed practitioners a greater involvement in research-based activities than they would currently expect. This involvement has enhanced their roles within their own respective organisations and has allowed them unrivalled opportunities to reflect on their own skills and practice.

A clear involvement of children with Autism Spectrum Conditions was also shown throughout. Typically under-represented in software design, participants with Autism Spectrum Conditions were able to embrace a key role as technology stakeholders. Carefully selected methodologies allowed them to have a direct impact on the development of the sharing tool. By removing the creative responsibility from the child user group, and placing more emphasis on an interpretation of their behaviours, children with Autism Spectrum Conditions can be deeply involved in the design process. Specific challenges of their involvement were overcome through the involvement of experienced practitioners in order to allow this group a much more direct role within the development than has previously been possible. This included scoping of activities, the provision of structure and the need for researcher familiarity. While these challenges may be specific to a user group with Autism Spectrum Conditions, an implementation of solutions within the wider population of users

demonstrates a good research practice that can improve participant involvement for all user groups.

Overall, the in-depth involvement of multiple participant groups in the research has presented challenges related to their potential for meaningful contribution. By adapting methodologies to incorporate the challenges and difficulties of each user group represented, each has been able to contribute to the research in a variety of roles commensurate with their preferences, abilities and experience.

References

AKERS, R., KROHN, M., LANZA-KADUCE, L. & RADOSEVICH, M. 1979. Social learning and deviant behaviour: A specific test of general theory. *American Sociological Review*, 44**,** 636-655.

ALBINSSON, P. & ZHAI, S. 2003. High precision touch screen interaction. *In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems.* Ft. Lauderdale, Florida, USA: ACM.

ALLEN, C., SILOVE, N., WILLIAMS, K. & HUTCHINS, P. 2007. Validity of the Social Communication Questionnaire in Assessing Risk of Autism in Preschool Children with Developmental Problems. *Journal of Autism and Developmental Disorders,* 37**,** 1272-1278.

ALLEN, S. & THRASHER, T. 1998. Peer interviewing: Sharing the selection process. *Nursing Management,* 29**,** 46.

ANDERSON, M., MURPHY, C., ALLEN, N., WOOD, C., SILVESTRI, S. & HEWARD, W. 2009. Promoting maintenance and generalization of learning. *In:* BOUTOT, A. & TINCANI, M. (eds.) *Autism Encyclopedia: The complete guide to Autism Spectrum Disorders.* Austin, TX: Pro-Ed Inc.

ANIMATED-SPEECH-CORPORATION. 2006. *ASC: Animated Speech Corporation* [Online]. Available: http://www.animatedspeech.com/ [Accessed 30th January 2011].

APA 1994. *Diagnostic and Statistical Manual of Mental Disorder,* Washington D.C., American Psychological Association.

ARNDT, T. S., C; RODIER, P 2005. The teratology of autism. *International Journal of Developmental Neuroscience,* 23**,** 189-199.

ASHLEY-KOCH, A., WOLPERT, C. M., MENOLD, M. M., ZAEEM, L., BASU, S., DONNELLY, S. L., RAVAN, S. A., POWELL, C. M., QUIMSIYEH, M. B., AYLSWORTH, A. S., VANCE, J. M., GILBERT, J. R., WRIGHT, H. H., ABRAMSON, R. K., DELONG, G. R., CUCCARO, M. L. & PERICAK-VANCE, M. A. 1999. Genetic Studies of Autistic Disorder and Chromosome 7. *Genetics,* 61**,** 227-236.

ASPERGER, H. T. B. F. U. 1944 [1991]. Autistic Psychopathy in Childhood. *Autism and Asperger Syndrome.* Cambridge University Press.

ATTWOOD, T. 2005. Theory of Mind & Asperger Syndrome. *In:* BAKER, L. & WELKOWITZ, L. (eds.) *Asperger Syndrome: Intervening in Schools, Clinics and Communities.* Routledge.

ATTWOOD, T. 2006. *The Complete Guide to Asperger's Syndrome,* Jessica Kingsley Publishers.

BAIRD, G. S., E; PICKLES, A; CHANDLER, S; LOUCAS, T; MELDRUM, D; CHARMAN, T 2006. Prevalence of disorders of the autism spectrum in a population cohort in South Thames: the Special Needs and Autism Project (SNAP). *The Lancet,* 368**,** 210-215.

BAKEMAN, R. & ADAMSON, L. 1984. Co-ordinating attention to people and objects in mother-infant and peer-infant interactions. *Child Development,* 55**,** 1278-1289.

BAKER, J. 2003. *Social skills training for children and adolescents with Asperger Syndrome and social-communication problems,* Shawnee Mission, Kansas, Autism Asperger Publishing Co.

BALDWIN, D. & MOSES, L. 1996. The ontogeny of social information gathering. *Child Development,* 67**,** 1915-1939.

BANDURA, A. & WALTERS, R. 1963. *Social learning and personality development,* New York, Holt, Rinehart & Winston.

BARNES, D., CARPENTER, J. & BAILEY, D. 2000. Partnerships with service users in interprofessional education of community mental health: a case study. *Journal of Interprofessional Care,* 14**,** 189-200.

BARON-COHEN, S. 1989. Joint-attention deficits in autism: Towards a cognitive analysis. *Development and Psychopathology,* 1**,** 185-189.

BARON-COHEN, S. 1995. *Mindblindness: An essay on autism and theory of mind,* Cambridge, MA: MIT Press.

BARON-COHEN, S. 2000. Theory of mind and autism: a review. *Special Issue of the International Review of Mental Retardation,* 23**,** 169-184.

BARON-COHEN, S., LESLIE, A. & FRITH, U. 1985. Does the autistic child have a "theory of mind"? *Cognition,* 21**,** 37-46.

BARON-COHEN, S. & WAY, R. 1997. Another advanced test of theory of mind: evidence from very high functioning adults with autism or Asperger Syndrome. *Journal of Child Psychology and Psychiatry,* 38**,** 813-822.

BARON-COHEN, S., WHEELWRIGHT, S., HILL, J., RASTE, Y. & PLUMB, I. 2001. The "Reading the Mind in the Eyes" Test, revised version: a study with normal adults with Asperger Syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry,* 42**,** 241-251.

BARRY, L. & BURLEW, S. 2004. Using social stories to teach choice and play skills to chidlren with Autism. *Focus on Autism and Other Developmental Disabilities,* 19**,** 45-51.

BATES, E. 1979. Intentions, conventions, and symbols. *In:* BATES, E. (ed.) *The emergence of symbols: cognition and communication in infancy.* New York: Academic Press.

BATES, E., CAMAIONI, L. & VOLTERRA, V. 1975. The acquisition of performatives prior to speech. *Merill-Palmer Quarterly,* 21**,** 205-226.

BELLINI, S. & PETERS, J. K. 2008. Social skills training for youth with autism spectrum disorders. *Child and Adolescent Psychiatric Clinics of North America,* 17**,** 857-873.

BERNARD-OPITZ, V., ROSS, K. & TUTTAS, M. 1990. Computer-Assisted Instruction for Autistic Children. *Annals of the Academy of Medicine,* 19**,** 611-616.

BERNARD-OPITZ, V., SRIRAM, N. & NAKHODA-SAPUAN, S. 2001. Enhancing social problem solving in children with autism and normal children through computer-assisted instruction. *J Autism Dev Disord,* 31**,** 377-84.

BERUMENT, S., RUTTER, M., LORD, C., PICKLES, A. & BAILEY, A. 1999. Autistic screening questionnaire: Diagnostic validity. *British Journal of Psychiatry,* 175**,** 441-451.

BLEDSOE, R., MYLES, B. S. & SIMPSON, R. L. 2003. Use of a Social Story intervention to improve mealtime skills of an adolescent with Asperger syndrome. *Autism,* 7**,** 289-295.

BOCK, M., ROGERS, M. & MYLES, B. S. 2004. Using social stories and comic strip conversations to interpret social situations for an adolescent with Asperger Syndrome. *Intervention in School and Clinic,* 36**,** 310-313.

BOLTON, P. E. A. 1997. Obstetric complications in autism: consequences or causes of the condition? *J Am Acad Child Adolesc Psychiatry,* 36**,** 272-281.

BORGERS, N., HOX, J. & SIKKEL, D. 2004. Response effects in surveys on children and adolescents: The effect of number of response options, negative wording, and neutral mid-point. *Quality and Quantity,* 38**,** 17-33.

BOSSELER, A. & MASSARO, D. 2003. Development and evaluation of a computer-animated tutor for vocabulary and language learning in children with Autism. *Journal of Autism and Developmental Disorders,* 33**,** 653-672.

BREAKWELL, G., HAMMOND, S. & FIFE-SCHAW, C. 1995. *Research methods in psychology,* London, Sage.

BROWN, L. & TANDON, R. 1983. Ideology and political economy in inquiry: action research and participatory research. *Journal of Applied Behavior Science,* 19**,** 277-294.

BRUINSMA, Y., KOEGEL, R. & KOEGEL, L. 2004. Joint attention and children with Autism: A review of the literature. *Mental Retardation and Developmental Disabilities Research Reviews,* 10**,** 169-175.

BRUNER, J. & SHERWOOD, V. 1983. Thought, language and interaction in infancy. *In:* GALESON, E. & TYSON, R. (eds.) *Frontiers of infant psychiatry.* New York: Basic Books.

BRYMAN, A. 2008. *Social Research Methods,* New York, Oxford University Press Inc.

CAMAIONI, L. 1992. Mind knowledhe in infancy: the emregence of intentional communication. *Early Development and Parenting,* 1**,** 15-22.

CARPENDALE, J. & LEWIS, C. 2006. *How children develop social understanding,* Blackwell Publishing Ltd.

CARTER, C., MECKES, L., PRITCHARD, L., SWENSEN, S., WITTMAN, P. P. & VELDE, B. 2004. The Friendship Club: an after-school program for children with Asperger syndrome. *Fam Community Health,* 27**,** 143-50.

CARTER, R. 2009. *The Brain Book,* Dorling Kindersley.

CASTELLI, F., FRITH, C., HAPPE, F. & FRITH, U. 2002. Autism, Asperger Syndrome and brain mechanisms for the attribution of mental states to animated shapes. *Brain,* 125**,** 1839-1849.

CHAMBERLAIN, B. 2011. *Isolation or involvement? The social networks of children with autism included in regular classes.* Doctoral Dissertation, University of California.

CHAMBERS, R. 1992. Rural Appraisal: Rapid, Relaxed and Participatory. Brighton: Institute for Development Studies Descussion Paper No 311.

CHAN, J. M. & O'REILLY, M. F. 2008. A Social StoriesTm Intervention Package for Students with Autism in Inclusive Classroom Settings. *Journal of Applied Behavior Analysis,* 41**,** 405-409.

CHANDLER, S., CHARMAN, T., BAIRD, G., SIMINOFF, E., LOUCAS, T., MELDRUM, D., SCOTT, M. & PICKLES, A. 2007. Validation of the Social Communication Questionnnaire in a Population Cohort of Children with Autism Spectrum Disorders. *Journal of the Academy of American Child and Adolescent Psychiatry,* 46**,** 1324-1332.

CHARMAN, T. 2003. Why is joint attention a pivotal skill in autism? *Philosophical Transactions of the Royal Society of Biological Sciences,* 358**,** 315-324.

CHATZOGLOU, P. & MACAULEY, L. 1996. Requirements capture and analysis: A survey of current practice. *Requirements Engineering,* 1**,** 75-87.

CHEN, S. & BERNARD-OPITZ, V. 1993. Comparison of Personal and Computer-Assisted Instruction for Children with Autism. *Mental Retardation,* 31**,** 368-376.

CHENG, Y., MOORE, D., MCGRATH, P. & FAN;, Y. 2005. Collaborative virtual environment technology for people with autism. *Advanced Learning Technologies, 2005. ICALT 2005. Fifth IEEE International Conference on***,** 247 - 248.

CHEW-GRAHAM, C. A., MAY, C. R. & PERRY, M. S. 2002. Qualitative research and the problem of judgement: lessons from interviewing fellow professionals. *Family practice,* 19**,** 285.

COATES, B., PUSSER, H. & GOODMAN, I. 1976. The influence of "Sesame Street" and "Mister Rogers Neighborhood" on children's social behavior in preschool. *Child Development,* 1.

COBB, S., BEARDON, L., EASTGATE, R., GLOVER, T., KERR, S., NEALE, H., PARSONS, S., BENFORD, S., HOPKINS, E., MITCHELL, P., REYNARD, G., WILSON, J. 2002. Applied virtual environments to support learning of social interaction in users with Asperger's Syndrome. *Digital Creativity,* 13**,** 11-22.

COHEN, I. 2003. Criterion-related validity of the PDD Behavior Inventory. *Journal of Autism and Developmental Disorders,* 33**,** 47-53.

COHEN, I., GOMEZ, T., GONZALEZ, M., LENNON, E., KARMEL, B. & GARDNER, J. 2010. Parent PDD Behavior Inventory Profiles of Young Children Classified According to Autism Diagnostic Observation Schedule - Generic and Autism Diagnostic Interview - Revised Criteria. *Journal of Autism and Developmental Disorders,* 40**,** 246-254.

COHEN, I., SCHMIDT-LACKNER, S., ROMANCZYK, R. & SUDHALTER, V. 2003. The PDD Behavior Inventory: A Rating Scale for Assessing Response to Intervention in Children with Pervasve Developmental Disorder. *Journal of Autism and Developmental Disorders,* 33**,** 31-45.

COHEN, I. & SUDHALTER, V. 2005. PDD Behavior Inventory (Manual ed.). Lutz, FL: Psychological Assessment Resources, Inc.

COHEN, J. 1960. A coefficient of agreement for nominal scales. *Educational and Psychological Measurement,* 20**,** 37-46.

COHEN, L., MANION, L. & MORRISON, K. 2000. *Research Methods in Education,* London, Routledge Falmer.

CONLON, T. & PAIN, H. 1996. Persistent Collaboration: A Methodology for Applied AIED. *Journal of Artificial Intelligence in Education,* 7**,** 219-253.

CONSTANTINO, J., DAVIES, S., TODD, R., SCHINDLER, M., GROSS, M., BROPHY, S., METZGER, L., SHOUSHTAIR, C., SPLINTER, R. & REICH, W. 2003. Validation of a Brief Quantitative Measure of Autistic Traits: Comparison of the Social Responsiveness Scale with the Autism Diagnostic Interview - Revised. *Journal of Autism and Developmental Disorders,* 33**,** 427-433.

CROZIER, S. & TINCANI, M. 2007. Effects of Social Stories on Prosocial Behavior of Preschool Children with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders,* 37**,** 1803-1814.

DAUTENHAHN, K. & WERRY, I. 2004. Towards interactive robots in autism therapy: background, motivation adn challenges. *Pragmatics and Cognition,* 12**,** 1-35.

DEGANGI, G. 2000. *Pediatric disorders of regulation in affect and behavior: A therapist's guide to assessment and treatment,* San Diego, CA, Academic Press.

DELANO, M. 2006. The effects of social stories on the social engagemtnet of children with autism. *Journal of Positive Behavior Interventions* 8**,** 29-42.

DELANO, M. & SNELL, M. E. 2006. The Effects of Social Stories on the Social Engagement of Children with Autism. *Journal of Positive Behavior Interventions,* 8**,** 29-42.

DENHAM, P. 1993. Nine to fourteen-year-old children's conception of computers using drawings. *Behaviour and Information Technology,* 12**,** 346-358.

DENNET, C. 1987. *The Inentional Stance,* Cambridge, MA, MIT Press.

DEQUINZIO, J. A., TOWNSEND, D. B. & POULSON, C. L. 2008. The effect of forward chaining and contingent social interaction on the acquisition of complex sharing responses by children with autism. *Research in Autism Spectrum Disorders,* 2**,** 264-275.

DISSANAYAKE, C. & MACINTOSH, K. 2003. Mind reading and social functioning in children with Autistic Disorder and Asperger's Disorder. *In:* REPACHOLI, B. & SLAUGHTER, V. (eds.) *Individual differences in Theory of Mind: Implications for typical and atypical development.* Hov: Psychology Press.

DIX, A., FINLAY, J., ABOWD, G. & BEALE, R. 1998. *Human Computer Interaction,* Hertfordshire, Prentice Hall.

DO2LEARN. 2009. *Faceland* [Online]. Available: http://www.do2learn.com/subscription/product_details/cd_Faceland.php [Accessed 02/01/10 2010].

DODD, S., HUPP, S. D. A., JEWELL, J. D. & KROHN, E. 2008. Using parents and siblings during a social story intervention for two children diagnosed with PDD-NOS. *Journal of Developmental and Physical Disabilities,* 20**,** 217-229.

DOHERTY, M. 2009. *Theory of Mind: How children understand others' thoughts and feelings,* Hove, Psychology Press.

DRUIN, A. 1998. Beginning a discussion about kids, technology, and design. *The design of children's technology.* Morgan Kaufmann Publishers Inc.

DRUIN, A. 1999. Cooperative inquiry: Developing new technologies for children with children. *CHI 99.* ACM Press.

DRUIN, A. 2002. The role of children in the design of new technology. *Behaviour & Information Technology,* 21**,** 1-25.

DUNN, L., DUNN, D. & STYLES, S. 2009. The British Picture Vocabulary Scales. 3 ed. Windsor: NFER Nelson.

ECHOES. 2009. *Welcome to the ECHOES Project* [Online]. Available: http://www.echoes2.org [Accessed 30/11/09 2009].

EHRLICH, K. & ROHN, J. 1994. Cost-justification of usability engineering: A vendor's perspective. *In:* BIAS, R. & MAYHEW, D. (eds.) *Cost-Justifying Usability.* Boston, MA: Academic Press.

EISENBERG, N. & MUSSEN, P. H. 1990. *The roots of prosocial behavior in children,* Cambridge, Cambridge University Press.

ENYON, A. 1997. Computer Interaction: An update on the AVATAR program. *Communication,* Summer.

FEINBERG, M. 2002. *Using social stories to teach specific social skills to individuals diagnosed with autism.*

FISCHER, G., JAMES, J. & SULLIVAN, F. 2002. Human-centred public transportation systems for persons with cognitive disabilities: Challenges and insights for participatory design. *Proceedings of the Participatory Design Conference.* ACM Press.

FISHER, P. & BALL, T. 2003. Tribal participatory research: mechanisms of a collective model. *American Journal of Community Psychology,* 32**,** 207-216.

FLEISS, J. L. 1971. Measuring nominal scale agreement among many raters. *Psychological Bulletin,* 76**,** 378-382.

FLICK, U. 2009. *An introduction of qualitative research,* Sage Publications Ltd.

FLYNN, D. 1992. *Information Systems Requirements: Determination and Analysis,* McGraw-Hill.

FONTANA, A. & FREY, J. 2005. The interview: From neutral stance to political involvement. *In:* DENZIN, N. & LINCOLN, Y. (eds.) *The Sage Handbook of Qualitative Research.* Thousand Oaks, CA: Sage.

FONTEYN, M., KUIPER, B. & GROBE, S. 1993. A description of think aloud method and protocol analysis. *Qualitative Health Research,* 3**,** 430-441.

FRAUENBERGER, C., GOOD, J., ALCORN, A. & PAIN, H. 2012. Supporting the design contributions of children with autism spectrum conditions. *Proceedings of the 11th International Conference on Interaction Design and Children (IDC '12).* Bremen, Germany.

FRAUENBERGER, C., GOOD, J. & KEAY-BRIGHT, W. 2010. Phenomenology, a Framework for Participatory Design. *Participatory Design Conference 2010.* Sydney, Australia: ACM.

FRAUENBERGER, C., GOOD, J. & KEAY-BRIGHT, W. 2011. Designing technology for children with special needs: bridging perspectives through participatory design. *CoDesign,* 7**,** 1-28.

GAGNON, E. 2001. *The PowerCard: using special interests to motivate children and youth with Asperger Syndrome and Autism,* Autism Asperger Publishing Company.

GAL, E., BAUMINGER, N., GOREN-BAR, D., PIANESI, F., STOCK, O., ZANCANARA, M. & WEISS, P. 2009. Enhancing social communication of children with high-functioning autism through a co-located interface. *AI & Society,* 24**,** 75-84.

GENA, A., KRANTZ, P., MCCLANNAHAN, L. & POULSON, C. 1996. Training and Generalization of Affective Behavior Displayed by Youth with Autism. *Journal of Applied Behavior Analysis,* 29**,** 291-304.

GESCHWIND, D. & LEVITT, P. 2007. Autism Spectrum Disorders: Developmental Disconnection Syndromes. *Current Opinions in Neurobiology,* 17**,** 103-111.

GHAZIUDDIN, M. 2005. A Family History Study of Asperger Syndrome. *Journal of Autism and Developmental Disorders,* 35**,** 177-182.

GILLBERG, C. 2002. *A Guide to Asperger Syndrome,* Cambridge University Press.

GILLBERG, I. C. & GILLBERG, C. 1989. Asperger Syndrome - some epidemiological considerations: a research note. *Journal of Child Psychology and Psychiatry,* 30**,** 631-638.

GLASER, B. & STRAUSS, A. 1997. *The discovery of grounded theory: strategies for qualitative research,* New York, Aldine de Gruyter.

GOLAN, O. & BARON-COHEN, S. 2006. Systemizing empathy: Teaching adults with Asperger Syndrome or high-functioning autism to recognize complex emotions using interactive multimedia. *Development and Psychopathology,* 18**,** 591-617.

GOLDSMITH, T. 2004. Use of Technology in Interventions for Children with Autism. *Journal of Early and Intensive Behaviour Intervention,* 1**,** 166-178.

GOOD, J. & ROBERTSON, J. 2006. CARSS: A Framework for Learner-Centred Design with Children. *International Journal of Artificial Intelligence in Education,* 16**,** 381-413.

GOODWIN, K. 2009. *Designing for the Digital Age: How to Create Human-Centred Products & Services*, Wiley Publishing Inc.

GOOLNIK, S., ROBERTSON, J. & GOOD, J. 2006. Learner Centred Design in the Adventure Author Project. *International Journal of Artifical Intelligence in Education,* 16**,** 415-438.

GOULD, R. & LEWIS, C. Year. Designing for Usability; Key Principles and What Designers Think. *In:* Proceedings of the SIGCHI conference on Human Factors in Computing Systems, 1983 Boston, Maccachusetts, USA. ACM.

GRANDIN, T. 2002. *Teaching tips for children and adults with Autism* [Online]. Autism Research Institute. Available: http://www.autism.com/families/therapy/teaching_tips.htm [Accessed 3 Jan 2012].

GRAY, C. 1994a. *Comic Strip Conversations,* Arlington, TX, Future Horizons.

GRAY, C. 1994b. *The New Social Story Book,* Arlington, VA, Future Horizons.

GRAY, C. 1995. Teaching children to 'read' social situations. *In:* QUILL, K. (ed.) *Teaching children with autism: strategies to enhance communication and socialisation.* Albany, NY: Delmar.

GRAY, C. 1998. Social stories and comic strip conversations with students with Asperger Syndrome and High-Functioning Autism. *In:* SCHOPLER, E., MESIBOV, G. & KUNCE, L. (eds.) *Asperger Syndrome or High-Functioning Autism?* New York: Plenum Press.

GRAY, C. 2000. Writing Social Stories with Carol Gray. Arlington: TX: Future Horizons.

GRAY, C. 2004. Social Stories 10.0. *Jensson Autism Journal*.

GRAY, C. 2008. The next generation: Social Stories, PowerPoint, Storymovies and More! *Geneva Centre for Autism International Symposium*. Geneva.

GRAY, C. & GARAND, J. 1993. Social Stories: Improving Responses of Students with Autism with Accurate Social Information. *Focus on Autism and other developmental disabilities,* 8**,** 1-10.

GREEN, L., GEORGE, M., DANIEL, M., FRANKISH, C., HERBERT, C. & BOWIE, W. 1994. *Study of participatory research in health promotion,* Ottawa, Royal Society of Canada.

GREY, C. & MALINS, J. 2004. *Visualizing Research: A Guide to the Research Process in Art and Design,* Ashgate Publishing Limited.

GRODEN, J., LEVASSEUR, P. & GOODWIN, M. 2006. Stress and Autism. *Autism Advocate.* Third ed.: Autism Society America.

GUHA, M., DRUIN, A. & FAILS, J. 2008. Designing with and for children with special needs: an inclusionary model. *Interaction Design and Children.* ACM Press.

GUSTEIN, S. E. & WHITNEY, T. 2002. Asperger Syndrome and the Development of Social Competence. *Focus on Autism and other Developmental Disabilities,* 17**,** 161-171.

HADWIN, J., BARON-COHEN, S., HOWLIN, P. & HILL, K. 1996. Can we teach children with autism to understand emotion, belief or pretence? *Development and Psychopathology,* 8**,** 345-365.

HAGIWARA, T. & MYLES, B. S. 1999. A multimedia Social Story intervention: Teaching skills to children with autism. *Focus on Autism and other developmental disabilities,* 14**,** 82-95.

HALL, K. 2010. *Evaluation of the Pervasive Developmental Disorder Behavior Inventory.* Master of the Arts, The Ohio State University.

HAPPE, F. 1994. An advanced test of theory of mind: understanding of story characters' thoughts and feelings by able autistic, mentally handicapped and normal children and adults. *Journal of Autism and Developmental Disorders,* 24**,** 129-154.

HAPPE, F. 1995. Understanding Minds & Metaphors: Insights from the study of figurative language in Autism. *Metaphor & Symbol,* 10**,** 275-295.

HEIDER, F. & SIMMEL, M. 1944. An experimental study of apparent behaviour. *American Journal of Psychology,* 57**,** 243-259.

HEIMANN, M., NELSON, K., TJUS, T. & GILLBERG, C. 1995. Increasing reading and communication skills in children with autism through an interactive meultimedia computer program. *Journal of Autism and Developmental Disorders,* 25**,** 459-480.

HIGGINS, K. & BOONE, R. 1996. Creating individualised computer-assisted instruction for students with autism using multimedia authoring software. *Focus on Autism and Other Developmental Disabilities,* 11**,** 69-78.

HILL, E., BERTHOZ, S. & FRITH, U. 2004. Brief Report: Cognitive Processing of own Emotions in Individuals with Autistic Spectrum Disorder and in Their Relatives. *Journal of Autism and Developmental Disorders,* 34.

HILL, M. 1997. Participatory Research with Children. *Child and Family Social Work,* 2**,** 171-183.

HIRANO, S., YEGANYAN, M., MARCU, G., NGUYEN, D., BOYD, L. & HAYES, G. 2010. vSked: evaluation of a system to support classrroom activities for children with autism. *Proceedings of CHI 2010.*

HOLTZBLATT, K. & BEYER, H. 1995. Requirements gathering: the human factor. *Communications of the ACM,* 38**,** 31-32.

HORNIG, M., BRIESE, T., BUIE, T., BAUMAN, M. L., LAUWERS, G., ET AL 2008. Lack of association between measles virus vaccine and autism with enteropathy: a case-control study. *PLoS ONE,* 3.

HORTON, M. & READ, J. 2008. Interactive whiteboards in the living room? Asking children about their technologies. *The 22nd British HCI 2008.* Liverpool, UK: British Computer Society.

HOWLEY, M. & ARNOLD, E. 2005. *Revealing the hidden social code: Social stories for people with Autistic Spectrum Disorders,* London, Jessica Kingsley Publishers.

HOWLIN, P. 1998. Practicioner Review: Psychological and educational treatments for Autism. *Journal of Child Psychology and Psychiatry,* 39**,** 307-322.

HOWLIN, P. 2003. Outcome in high-functioning adults with autism with and without language delays: Implications for the differentiation between autism and asperger syndrome. *Journal of Autism and Developmental Disorders,* 33**,** 3-13.

HOWLIN, P. & ASGHARIAN, A. 1999. The diagnosis of autism and Asperger syndrome: findings from a survey of 770 families. *Dev Med Child Neurol,* 41**,** 834-9.

HOWSON, H., WHALEY, G. & WALLER, A. 2004. Design and evaluation of a home/school communcation aid for young people with autism. *11th Biennial Conference for the International Society for Augmentative and Alternative Communication.* Natal, Brazil.

ISO 2010. 9241-210 Human-centred design processes for interactive systems. International Standards Organization for Standardization.

JONES, C., MCIVER, L., GIBSON, L. & GREGOR, P. Year. Experiences obtained from designing with children. *In:* IDC "03: Proceedings of the 2003 conference on Interaction design and children, 2003 New York, USA. ACM, 69-74.

JORDAN, R. & JONES, G. 1999. *Meeting the Needs of Children with Autistic Spectrum Disorders,* London, Fulton.

JOYAPPA, V. & MIARTIN, D. 1996. Exploring Alternative Research Epistemologies for Adult Education: Participatory Research, Feminist Research and Feminist Participatory Research. *Adult Education Quarterly,* 47**,** 1-14.

KAMPS, D., LEONARD, B., VERNON, S., DUGAN, E., DELQUADRI, J., GERSHON, B., WADE, L. & FOLK, L. 1992. Teaching social skills to students with autism to increase peer interactions in an integrated first-grade classroom. *Journal of Applied Behavior Analysis,* 25**,** 281-288.

KANNER, L. 1943. Autistic disturbances of affective contact. *Nervous child,* 2**,** 217-230.

KARAT, C. 1997. Evolving the scope of user-centred design. *Communications of the ACM,* 40**,** 33-38.

KEAY-BRIGHT, W. 2007a. Can computers create relaxation? Designing ReacTickles software with children on the autistic spectrum. *CoDesign,* 3**,** 97-110.

KEAY-BRIGHT, W. 2007b. The Reactive Colours Project: Demonstrating Participatory and Collaborative Design Methods for the Creation of Software for Autistic Children. *Design Principles & Practices: An International Journal,* 1**,** 7-15.

KELLEY, M., HEFFER, R., GRESHAM, F. & ELLIOT, S. 1989. Development of a modified Treatment Evaluation Inventory. *Journal of Psychopathology and Behavioral Asessment,* 11**,** 235-247.

KINDON, S., PAIN, R. & KESBY, M. 2007a. Connecting people, participation and place. *In:* KINDON, S., PAIN, R. & KESBY, M. (eds.) *Participatory Action Research Approaches and Methodologies.* New York: Routledge.

KINDON, S., PAIN, R. & KESBY, M. 2007b. Participatory Action Research: Origins, Approaches and Methods. *In:* KINDON, S., PAIN, R. & KESBY, M. (eds.) *Participatory Action Research Approaches and Methodologies.* New York Routledge.

KLEIN-TASMAN, B., RISI, S. & LORD, C. 2007. Effect of Language and Task Demands on the Diagnostic Effectiveness of the Autism Diagnostic Observation Schedule: The Impact of Module Choice. *Journal of Autism and Developmental Disorders,* 37.

KLIN, A. 2000. Attributing social meaning to ambiguous visual stimuli in higher-functioning autism and Asperger syndrome: the Social Attribution Task. *Journal of Child Psychology and Psychiatry,* 41**,** 831-846.

KLIN, A., JONES, W., SCHULTZ, R., VOLKMAR, F. & COHEN, D. 2002a. Defining and quantifying the social phenotype in autism. *American Journal of Psychiatry,* 159.

KLIN, A., JONES, W., SCHULTZ, R., VOLKMAR, F. & COHEN, D. 2002b. Visual fixation patterns during viewing of naturalistic social situations as predictors of social competence in individuals with autism. *Archives of General Psychiatry,* 59**,** 809-816.

KLIN, A., SAULNIER, C., SPARROW, S., CICCHETTI, D., VOLKMAR, F. & LORD, C. 2007. Social and Communication Abilities and Disabilities in Higher Functioning Individuals with Autism Spectrum Disorders: The Vineland and the ADOS. *Journal of Autism and Developmental Disorders,* 37**,** 748-759.

KLIN, A. & VOLKMAR, F. 2003. Asperger Syndrome and external validity. *Child and Adolescent Clinics of North America,* 12**,** 1-13.

KOEGEL, R., KOEGEL, L., FREA, P. & SMITH, J. 1995. "Teach the Individual" Model of Generalization: Autonomy Through Self-Management. *In:* KOEGEL, R. & KOEGEL, L. (eds.) *Teaching Children with Autism: Strategies for Initiating Positive Interactions and Improving Learning Opportunities.* Baltimore, MD: Brookes Publishing.

KOTONYA, G. & SOMMERVILLE, I. 1998. *Requirements Engineering: Processes and Techniques,* Chichester, John Wiley & Sons Ltd.

KRANTZ, P. J. & MCCLANNAHAN, L. E. 1998. Social interaction skills for children with autism: A script-fading procedure for beginning readers. *Journal of Applied Behavior Analysis,* 31**,** 191-202.

KUJALA, S. 2003. User Involvement: a review of the benefits and challenges. *Behaviour & Information Technology,* 22**,** 1-16.

KUOCH, H. & MIRENDA, P. 2003. Social Story Interventions for Young Children With Autism Spectrum Disorders. *Focus on Autism and Other Developmental Disabilities,* 18**,** 219-227.

KUTTLER, S., MYLES, B. & CARLSON, J. 1998. The use of social stories to reduce precursors to tantrum behavior in a student with autism. *Focus on Autism and other developmental disabilities,* 13.

LAHNO, B. 1995. Trust, reputation, and exit in exchange relationships. *Journal of Conflict Resolution,* 39**,** 495-510.

LANCET, E. T. 2010. Retraction - Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children.

LANDIS, J. R. & KOCH, G. G. 1977. The measurement of observer agreement for categorial data. *Biometrics,* 33**,** 159-174.

LAZAR, J., FENG, J. & HOCHHEISER, H. 2010. *Research methods in human-computer interaction,* Chichester, John Wiley & Sons Ltd.

LECAVALIER, L., AMAN, M., SCAHILL, L., MCDOUGIE, C., MCCRACKEN, J., VITIELLO, B., TIERNAY, E., ARNOLD, L., GHUMAN, J., LOFTIN, R., CRONIN, P., KOENIG, K., POSEY, D., MARTIN, A., HOLLWAY, J., LEE, L. & KAU, A. 2003. Validity of the Autism Diagnostic Interview - Revised. *American Journal on Mental Retardation,* 111**,** 119-215.

LECOUNTEUR, A., RUTTER, M., LORD, C., RIOS, P., ROBERTSON, S. & HOLDGRAFER, M. 1989. Autism diagnostic interview: A standardised Investigator-based instrument. *Journal of Autism and Developmental Disorders,* 19**,** 363-387.

LEE, L. 1992. *The Day the Phones Stopped: How People Get Hurt When Computers Go Wrong,* New York, Primus Donald I. Fine, Inc.

LEEKHAM, S., LOPEZ, B. & MOORE, C. 2000. Attention and Joint Attention in Preschool Children with Autism. *Developmental Psychology,* 36**,** 261-273.

LESTER, B., FREIER, K. & LAGASSE, L. 1995. Prenatal cocaine exposure and child outcome: What do we really know. *In:* LEWIS, M. & BENDERSKY, M. (eds.) *Mothers, babies and cocaine: The role of toxins in development.* Hillsdale, NJ: Erlbaum.

LEWIS, C. & RIEMAN, J. 1993. *Task-Centered User Interface Design*, University of Colorado.

LIBBY, S., POWELL, S., MESSER, D. & JORDAN, R. 1997. Imitation of pretend play acts by children with autism and down syndrome. *Journal of Autism and Developmental Disorders,* 27**,** 365-381.

LORD, C., FLOODY, H., ANDERSON, D. & PICKLES, A. 2003. Social engagement in very young chidlren with autism: Differences across conetexts. *The Society for Research in Child Development*.

LORD, C. & PAUL, R. 1997. Language and communication in autism. *In:* COHEN, D. & VOLKMAR, F. (eds.) *Handbook of autism and pervasive developmental disorders.* New YorkWiley & Sons.

LORD, C., PICKLES, A., MCLENNAN, J., RUTTER, M., BREGMAN, J., FOLSTEIN, S., FROMBONNE, E., LEBOYER, M. & MINSHEW, N. 1997. Diagnosing Autism: Analyses of Data from the Autism Diagnostic Interview. *Journal of Autism and Developmental Disorders,* 27**,** 501-517.

LORD, C., RISI, S., LAMBRECHT, L., COOK, E. H., LEVENTHAL, B. L., DILAVORE, P. C., PICKLES, A. & RUTTER, M. 2000. The autism diagnostic observation schedule-generic: a standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders,* 30**,** 205-223.

LORD, C., RUTTER, M., DILAVORE, P. & RISI, S. 2001. *Autism Diagnostic Observations Schedule (ADOS) manual,* Los Angeles, CA, Western Psychological Services.

LORD, C., RUTTER, M. & LECOUTEUR, A. 1994. Autism Diagnostic Interview - Revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders,* 24**,** 659-685.

LORIMER, P. A., SIMPSON, R. L., MYLES, B. S. & GANZ, J. B. 2002. The use of social stories as a preventative behavioral intervention in a home setting with a child with autism. *Journal of Positive Behavior Interventions,* 4**,** 53-60.

LOSH, M. & PIVEN, J. 2007. Social-cognition and the broad autism phenotype: identifying genetically meaningful phenotypes. *Journal of Child Psychology and Psychiatry,* 48**,** 105-112.

LOVELAND, K., LANDRY, S., HUGHES, S., HALL, S. & MCEVOY, R. 1988. Speech acts and pragmatic deficits of autism. *Journal of Speech and Hearing Research,* 31**,** 593-604.

MACAULEY, A., PARADIS, G., POTVIN, L., CROSS, E., SAAD-HADDAD, C. & MCCOMBER, A. 1997. The Kahnawake Schools diabetes project: intervention, evaluation and baseline results of a diabetes primary prevention program with a Native community in Canada. *Preventative Medicine,* 26**,** 770-790.

MACDUFF, KRANTZ & MCCLANNAHAN 2001. Prompts and prompt-fading strategies for people with autism. *In:* MAURICE, C. & GREEN, G. (eds.) *Making a difference: Behavioral Intervention for Autism.* Austin, TX: Pro-Ed.

MACPHAIL, A. & KINCHIN, G. 2004. The use of drawings as an evaluative tool: students' experiences of Sport Education. *Physical Education and Social Science,* 9**,** 88-108.

MAHMUD, M. & KURNIAWAN, H. 2005. Involving pschometric tests for input device evaluation with older people. *Conference on Computer-Human Interactions: Citizens online: Considerations For Today and the Future.* Canberra, Australia.

MAKATON. 2011. *Makaton* [Online]. Available: http://www.makaton.org [Accessed 12th October 2011 2011].

MARCUS, L. 2010. *Structured teaching by TEACCH staff* [Online]. UNC School of Medicine. Available: http://teacch.com/educational-approaches/structured-teaching-teacch-staff [Accessed 3 Jan 2011].

MARTI, P. & GIUSTI, L. 2010. A robot companion for inclusive games: a user-centred design perspective. *2010 IEEE International Conference on Robotics and Automation (ICRA).* Anchorage, AK: IEEE.

MASSARO, D. & BOSSELER, A. 2006. Read my lips: The importance of the face in a computer-animated tutor for autistic children learning language. *Autism: The International Journal of research and Practice,* 10**,** 495-510.

MAZZONE, E., IIAVARI, N., TIKKANEN, R., READ, J. & BEALE, R. 2010. Considering context, content, management and engagement in design activities with children. *IDC 2010*. Barcelona, Spain: ACM.

MCTAGGART, R. 1997. *Participatory action research: International contexts and consequences,* New York, State of New York University Press.

MESIBOV, G. B., SHEA, V. & SCHOPLER, E. 2005. *The TEACCH Approach to Autism Spectrum Disorders,* New York, Kluwer Academic/Plenum.

MICROSOFT. 2010. *Microsoft Office: PowerPoint* [Online]. Available: http://office.microsoft.com/en-gb/powerpoint/ [Accessed Tuesday 27th December 2011].

MILLEN, L., COBB, S. & PATEL, H. 2010a. Participatory design with children with autism. *The 8th International Conference on Disability, Virtual Reality and Associated Technologies.* Valparaiso, Chile.

MILLEN, L., COBB, S. & PATEL, H. 2011. A method for involving children with autism in design. *IDC 2011.* Ann Arbor, USA: ACM.

MILLEN, L., EDLIN-WHITE, R. & COBB, S. 2010b. The development of educational collaborative virtual environments for chidlren with autism. *Proceedings of the 5th Cambridge Workshop on Universal Access and Assistive Technology.* Cambridge.

MOLICH, R., LAUREL, B., SNYDER, C., QUEENSBERY, W. & WILSON, C. 2001. Ethics in HCI. *CHI '01.* Seattle, Washington: ACM.

MOORE, D. 1998. Computers and people with autism / asperger syndrome. *Communication (the magazine of the National Autistic Society).*

MOORE, M. & CALVERT, S. 2000. Brief report: vocabulary acquisition for children with autism: teacher or computer instruction. *Journal of Autism and Developmental Disorders,* 30**,** 359-362.

MULLER, M. & HASLWANTER, J. H. 1997. Participatory practices in the software lifecycle. *In:* HELANDER, M., LANDAUER, T. & PRABHU, P. (eds.) *Handbook of Human-Computer Interaction.* Amsterdam: Elsevier.

MUNDY, P., SIGMAN, M., UNGERER, J. & SHERMAN, T. 1986. Defining the social deficits of autism: The contribution of non-verbal communication measures. *Journal of Child Psychology and Psychiatry,* 27**,** 657-669.

MURRAY, D. 1997. Autism and information technology: therapy with computers. *In:* POWELL, S. & JORDAN, R. (eds.) *Autism and learning: a guide to good practice.* London.

MURRAY, D., LESSER, M. & LAWSON, W. 2005. Attention, monotropism and the diagnostic criteria for autism. *Autism,* 9**,** 139-156.

MYLES, B., HAGIWARA, T., DUNN, W., RINNER, L., REESE, M., HUGGINS, A. & BECKER, S. 2004. Sensory Issues in Children with Asperger Syndrome and Autism. *Education and Training in Developmental Disabilities,* 39**,** 283-290.

MYLES, B. S. 2004. An Overview of Asperger Syndrome. *In:* BAKER, J. (ed.) *Social Skills Training for Children and Adolescents with Asperger Syndrome and Social-Communication Problems.* Shawnee Mission, Kansas: Autism Asperger Publishing Co.

NATIONAL AUTISTIC SOCIETY, T. 2007. *Statistics: how many people have autistic spectrum disorders* [Online]. Available: http://www.nas.org.uk/nas/jsp/polopoly.jsp?d=235&a=3527 [Accessed 20th December 2009].

NATIONAL AUTISTIC SOCIETY, T. 2008. *The National Autistic Society* [Online]. Available: http://www.autism.org.uk/nas/jsp/polopoly.jsp?d=170&a=3349 [Accessed 14/05/10 2010].

NATIONAL RESEARCH COUNCIL, T. 2001. Educating children with autism. . Washington DC.

NEALE, H. 1998. The potential of virtual reality for people with autism. Internal VIRART report on outcomes of a one-day NAS IT seminar. University of Nottingham.

NIELSEN, J. 1994. Heuristic Evaluation. *Usability Inspection Methods*. New York: John Wiley & Sons.

NOYES, J., STARR, A. & FRANKISH, C. 1996. User involvement in the early stages of the development of an aircraft warnign system. *Behaviour & Information Technology,* 15**,** 67-75.

NUSEIBEH, B. & EASTERBROOK, S. 2000. Requirements engineering: a roadmap. *Proceedings of the Conference on the future of software engineering*

OLSSON, E. 2004. What active users and designers contribute in the design process. *Interacting with Computers,* 16**,** 377-401.

ORMROD, J. 1999. *Human Learning*, Upper Saddle River, NK, Prentice Hall.

ORNITZ, E., GUTHRIE, D. & FARLEY, A. 1997. The Early Development of Autistic Children. *Journal of Autism and Developmental Disorders,* 7.

OSPINA, M. B., KREBS SEIDA, J., CLARK, B., KARKHANEH, M., HARTLING, L., TJOSVOLD, L., VANDERMEER, B. & SMITH, V. 2008. Behavioural and Developmental Interventions for Autism Spectrum Disorder: A Clinical Systematic Review. *PLoS ONE,* 3**,** e3755.

OSTERLING, J. & DAWSON, G. 1994. Early recognition of children with autism: A study of first birthday home videotapes. *Journal of Autism and Developmental Disorders,* 24**,** 247-257.

OSTERLING, J., DAWSON, G. & MUNSON, J. 2002. Early recognition of 1-year-old infants with autism spectrum disorder versus mental retardation. *Development and Psychopathology,* 14**,** 239-251.

OZDEMIR, S. 2008. Using multimedia social stories to increase appropriate social engagement in young children with autism. *The Turkish Online Journal of Educational Technology,* 7.

OZONOFF, S. & CATHCART, K. 1998. Effectiveness of a home program intervention for young children with autism. *Journal of Autism and Developmental Disorders,* 28**,** 25-32.

OZONOFF, S. & MILLER, J. 1995. Teaching theory of mind: A new approach to social skills training for individuals with autism. *Journal of Autism and Developmental Disorders,* 25**,** 415-433.

PAIN, R. & FRANCIS, P. 2003. Reflections on participatory research. *Area,* 31**,** 46-54.

PANT, M. 2007. Participatory Research. *Participatory lifelong learning and information and communication technologies.* New Delhi: School of Social Sciences, Jarwaharlal Nehru University.

PANYAN, M. V. 1984. Computer Technology for Autistic Children. *Journal of Autism and Developmental Disabilities,* 14**,** 375-382.

PAPERT, S. & HAREL, I. 1991. Situating Constructionism. *In:* PAPERT, S. & HAREL, I. (eds.) *Constructionism.* Ablex Publishing Corporation.

PARES, N., CARRERAS, A., DURANY, J., FERRER, J., FREIXA, P., GOMEZ, D., KRUGLANSKI, O., PARES, R., RIBAS, J. I., SOLER, M. & SANJURJO, A. 2005. Promotion of creative activity in children with severe autism through visuals in an interactive multisensory environment. *Interaction Design for Children.* ACM Press.

PARSONS, S., BEARDON, L., NEALE, H. R., REYNARD, G., EASTGATE, R., WILSON, J. R., COBB, S. V. G., BENFORD, S. D., MITCHELL, P. & HOPKINS, E. 2000. Development of social skills amongst adults with Asperger's Syndrome using virtual environments. *Proc. 3rd Intl Conf. Disability, Virtual Reality & Assoc. Tech.***,** 163-170.

PARSONS, S., MITCHELL, P., LEONARD, A 2004. The use and understanding of virtual environments by adolescents with autistic spectrum disorders. *Journal of Autism and Developmental Disorders,* 34**,** 449-466.

PATTON, M. 2002. *Qualitative research and evaluation methods,* Thousand Oaks, CA, Sage.

PELPHREY, K. A., MORRIS, J. P. & MCCARTHY, G. 2005. Neural basis of eye gaze processing deficits in autism. *Brain,* 128**,** 1038-1048.

PENNINGTON, B. F., SNYDER, K. A. & JR, R. J. R. 2007. Developmental cognitive neuroscience: Origins, issues and prospects. *Developmental Review,* 27**,** 428-441.

PERNER, J. & WIMMER, H. 1985. "John thinks that Mary thinks that…" Attribution of second-order beliefs by 5-10 year old children. *Journal of Experimental Child Psychology,* 4**,** 375-383.

PERSICO, A. E. A. 2001. Reelin gene alleles and haplotypes as a factor predisposing to autistic disorder. *Molecular Psychiatry,* 5**,** 150-159.

PFISTER, M. 1996. *The Rainbow Fish,* North-South Books Inc.

PIAGET, J. 1962. *Play, Dreams and Imitation in Childhood,* New York, Norton.

PIMLEY, L. & BOWEN, M. 2006. *Supporting Pupils with Autistic Spectrum Disorders: A Guide for School Support Staff,* Sage Publications Ltd.

PLAISANT, C., DRUIN, A., LATHAN, C., DAKHANE, K., EDWARDS, K., VICE, J. & MONTEMAYOR, J. 2000. A storytelling robot for pediatric rehabilitation. *ASSETS.* ACM Press.

PLIMMER, B. & APPERLEY, M. 2004. INTERACTING with Sketched Interface designs: An Evaluation Study. *CHI 2004.* Vienna, Austria: ACM.

PLOUGH, A. & OLAFSON, E. 1994. Implementing Boston Healthy Start Initiative: a case study of community empowerment and public health. *Health Education Quarterly,* 21**,** 221-234.

POLE, C. & MORRISON, M. 2003. *Ethnography for Education,* Open University Press.

PORAYSKA-POMSTA, K., FRAUENBERGER, C., PAIN, H., RAJENDRAN, G., SMITH, T., MENZIES, R., FOSTER, M., ALCORN, A., WASS, S., BERNADINI, S., AVRAMIDES, K., KEAY-BRIGHT, W., CHEN, J., WALLER, A., GULDBERG, K., GOOD, J. & LEMON, O. 2011. Developing technology for autism: an interdisciplinary approach. *Personal and Ubiquitous Computing***,** 1-11.

POWELL, S. 1996. The use of computer in teaching people with autism. Autism on the Agenda. *Papers from a National Autistic Society Conference.* National Autistic Society.

PREECE, J., ROGERS, Y. & SHARP, H. 2002. *Interaction design: Beyond human-computer interaction,* New York, John Wiley & Sons, Inc.

PREECE, J., ROGERS, Y. & SHARP, H. 2007. *Interaction Design: Beyond Human-Computer Interaction,* Chichester, John Wiley & Sons Ltd.

PREECE, J., ROGERS, Y., SHARP, H., BENYON, D., HOLLAND, S. & CAREY, T. 1994. *Human-Computer Interaction,* Harlow, Pearson Education.

PRIZANT, B. 1983. Language and communication in autism: Toward an understanding of the "whole" of it. *Journal of Speech and Hearing Disorders,* 48**,** 296-307.

PRIZANT, B. & RUBIN, E. 1999. Contemporary issues in interventions for autism spectrum disorders: A commentary. *Journal of The Association for Perons with Severe Handicaps,* 24**,** 199-217.

PRIZANT, B. & WETHERBY, A. 1987. Communicative intent: A framework for understanding social-communicative behaviour in autism. *Journal of the American Academy of Child and Adolescent Psychiatry,* 26**,** 472-479.

PRIZANT, B., WETHERBY, A., RUBIN, E., LAURENT, A. & RYDELL, P. 2008a. *The SCERTS Model: Volume 1: Assessment,* Paul Brookes Publishing Co.

PRIZANT, B., WETHERBY, A., RUBIN, E., LAURENT, A. & RYDELL, P. 2008b. *The SCERTS Model: Volume 1: Assessment, p.1,* Paul Brookes Publishing Co.

PRIZANT, B., WETHERBY, A., RUBIN, E., LAURENT, A. & RYDELL, P. 2008c. *The SCERTS Model: Volume 2: Program Planning and Intervention,* Paul Brookes Publishing Co.

PRIZANT, B., WETHERBY, A. M., RUBIN, E., LAURENT, A. C. & RYDELL, P. 2006. *The SCERTS Model: A Comprehensive Educational Approach for Children with Autism Spectrum Disorders,* Baltimore, MD, Paul Brookes Publishing Co.

PUTNAM, C. & CHONG, L. 2008. Software and technologies designed for people with autism: what do users want? *Proceedings of the 10th International ACM SIGACCESS Conference on Computers and Accessibility.* ACM.

QUILL, K. 1995. *Teaching children with autism: Strategies to enhance communication and socialization,* New York, Delmar.

RAJENDRAN, G. & MITCHELL, P. 2007. Cognitive theories of autism. *Developmental Review,* 27**,** 224-260.

RAJENDRAN, G., MITCHELL, P. & RICKARDS, H. 2005. How do Individuals with Asperger Syndrome Respond to Nonliteral Language and Inappropriate Requests in Computer-mediated Communication? *J Autism Dev Disord,* 35**,** 429-443.

RAJENDRAN, G., MITCHELL, P. 2000. Computer mediated interaction in Asperger's Syndrome: the Bubble Dialogue program. *Computers & Education,* 35**,** 189-207.

RAO, P., BEIDEL, D. & MURRAY, M. 2008. Social Skills interventions for Children with Asperger's Syndrome or High-Functioning Autism: A Review and Recommendations. *Journal of Autism and Developmental Disorders***,** 353-361.

RAZNAHAN, A. & BOLTON, P. 2008. Autism Spectrum disorder in childhood. *Child Psychiatry and Developmental Disorders,* 36**,** 489-492.

READ, J. 2008. Validating the Fun Toolkit: an instrument for measuring children's opinions of technology. *Cognition, Technology and Work,* 10**,** 119-128.

READ, J., FITTON, D. & MAZZONE, E. 2010. Using obstructed theatre with child designers to convey requirements. *CHI 2010.* Atlanta, GA, USA: ACM.

READ, J., GREGORY, P., MACFARLANE, S., MCMANUS, B., GRAY, P. & PATEL, R. 2002. An investigation of participatory design with children - informant, balanced and facilitated design. *Interaction Design and Children.* Preston, England: Shaker Publishing.

REASON, P. & BRADBURY, H. 2001. *Handbook of Action Research,* London, Sage Publications.

REDDY, V., WILLIAMS, E. & VUAGHAN, A. 2002. Sharing humour and laughter in autism and Down's Syndrome. *British Journal of Psychology,* 93**,** 219-242.

REHFELDT, R., KINNEY, E., ROTT, S. & STROMER, R. 2004. Creating activity schedules using microsoft powerpoint. *Journal of Applied Behavior Analysis,* 37.

REICHLE, J., DROPIK, P. & ALDEN-ANDERSON, E. 2008. Teaching a Young Child with Autism to Request Assistance Conditionally: A Preliminary Study. *American Journal of Speech-Language Pathology,* 17**,** 231-240.

REIDL, M., ARRIAGA, R., BOUJARWAH, F., HONG, H., ISBELL, J. & HEFLIN, L. J. Year. Graphical Social Scenarios: Toward intervention and authoring for adolescnets with high functioning autism. *In:* AAAI Fall Symposium on Virtual Healthcare Interaction, 2009. Arlington.

REYNHOUT, G. & CARTER, M. 2009. The use of Social Stories by teachers and their perceived efficacy. *Research in Autism Spectrum Disorders,* 3**,** 232-251.

RHEINGOLD, H. L., HAY, D. F. & WEST, M. J. 1976. Sharing in the second year of life. *Child Development,* 47**,** 1148-1158.

RHOADES, M. & KROTOCHWILL, T. 1998. Parent training and consultation: An analysis of a homework intervention program. *School of Psychology Quarterly,* 13**,** 241-264.

RICCIARDELLI, D. 2006. *A social skills program evaluation: will social stories combone with a traditional social skills curriculum increase pro-social behavior in autistic children? ,* Fairleigh Dickinson University.

ROBINS, B., DAUTENHAHN, K., BOEKHORST, R. T. & BILLARD, A. 2005. Robotic assistants in therapy and education of children with autism: can a small humanoid robot help encourage social interaction skills? *Universal Access in the Information Society* 4**,** 105-120.

ROBINS, B., DAUTENHAHN, K. & DUBOWSKI, J. 2006. Does appearance matter in the interaction of children with autism with a humanoid robot? *Interaction Studies,* 7**,** 509-542.

ROBINS, B., FERRARI, E. & DAUTENHAHN, K. 2008. Developing scenarios for robot assisted play. *17th IEEE International Workshop on Robot and Human Interactive Communication - RO-MAN 2008.* Munich, Germany.

ROGERS, S. 2000. Interventions That Facilitate Socialization in Children with Autism. *Journal of Autism and Developmental Disorders,* 30**,** 399-409.

ROWE, C. 1999. Do Social Stories Benefit Children with Autism in Mainstream Primary Schools? *British Journal of Special Education,* 26**,** 12-14.

RUBENSTEIN, R. & HERSH, H. 1984. *The Human factor: Designing Computer Systems for People.*, Digital Press.

RUTTEN, A., COBB, S., NEALE, H., KERR, S., LEONARD, A., PARSONS, S. & MITCHELL, P. 2003. The AS interactive project: single-users and collaborative virtual enviroments for people with high-functioning autistic spectrum disorders. *The Journal of Visualization and Computer Animation***,** 233-241.

RUTTER, M., BAILEY, A. & LORD, C. 2003a. *Social Communication Questionnaire,* Oxford, Test Agency Ltd.

RUTTER, M., LECOUNTEUR, A. & LORD, C. 2003b. *Autism Diagnostic Interview, Revised (ADI-R),* Los Angeles, CA, Western Psychological Services.

SANSOSTI, F. & POWELL-SMITH, K. 2008. Using Computer-Presented Social Stories and Video Models to Increase the Social Communication Skills of Children With High-Functioning Autism Spectrum Disorders. *Journal of Positive Behavior Interventions,* 10**,** 162-178.

SANSOSTI, F., POWELL-SMITH, K. & KINCAID, D. 2004. A research synthesis of social story interventions for children with Autism Spectrum Disorders. *Focus on Autism and Other Developmental Disabilities,* 19**,** 194-204.

SCAIFE, M., ROGERS, Y., ALDRICH, F. & DAVIES, M. 1997. Designing For or Designing With? Informant Design for Interactive Learning Environments. *CHI '97.* Atlanta: ACM Press.

SCATTONE, D. 2007. Social skills interventions for children with autism. *Psychology in the Schools,* 44**,** 717-726.

SCATTONE, D. 2008. Enhancing the conversation skills of a boy with Asperger's Disorder through Social Stories (TM) and video modeling. *Journal of Autism and Developmental Disorders,* 38**,** 395-400.

SCHEEREN, A. M. & STAUDER, J. E. A. 2008. Broader Autism Phenotype in Parents of Autistic Children: Reality or Myth? *J Autism Dev Disord,* 38**,** 276-287.

SCHEUERMANN, B. & WEBBER, J. 2002. *Autism: Teaching DOES make a difference,* Belmont, CA, Wadsworth-Thomson Learning.

SCHREIBMAN, L. 1988. *Autism,* Newbury Park, CA, Sage Publications.

SCHREIBMAN, L. & INGERSOLL, B. 2000. The use of video priming to reduce disruptive behavior in children with autism. *Journal of Positive Behavioral Interventions,* 2**,** 3-11.

SCHULER, D. & NAMIOKA, A. 1993. *Participatory Desogn: Principles and Practices,* Hillsdale, NJ, Lawrence Erlbaum.

SCOTT, R. & SHORE, A. 1979. *Why sociology does not apply: A study of the use of sociology in public planning,* New York, Elsevier.

SCOTTISH-EXECUTIVE 2004. A Curriculum For Excellence: The Curriculum Review Group. Edinburgh.

SEIBERT, J., HOGAN, A. & MUNDY, P. 1982. Assessing interactional competencies: The Early Social-Communication Scales. *Infant Mental Health Journal,* 3**,** 244-245.

SENSE, A. 2006. Driving the bus from the rear passenger seat: control dilemas in participative action research. *International Journal of Social Research Methodology,* 9**,** 1-13.

SICILE-KIRA, C. 2003. *Autism Spectrum Disorders: The Complete Guide,* Vermilion.

SIGMAN, M. & RUSKIN, E. 1999. Continuity and change in social competence of children with autism, Down Syndrome, and developmental delays. *Monographs of the Society for Research in Child Development,* 64.

SILVER, M. & OAKES, P. 2001. Evaluation of a New Computer Intervention to Teach People with Autism or Asperger Syndrome to Recognize and Predict Emotions in Others. *Autism,* 5**,** 299-316.

SIMPSON, A., LANGONE, J. & AYRES, K. 2004. Embedded Video and Computer Based Instruction to Improve Social Skills for Students with Autism. *Education and Training in Developmental Disabilities,* 39**,** 240-252.

SLAUGHTER, V., DENNIS, M. & PRITCHARD, M. 2002. Theory of mind and peer acceptance in preschool children. *British Journal of Developmental Pscychology,* 20**,** 545-564.

SMITH, A. 1997. *Human Computer Factors: A Study of Users and Information Systems,* London, McGraw-Hill Publishing Company.

SODIAN, B., TAYLOR, C., HARRIS, P. & PERNER, J. 1991. Early deception and the child's theory of mind: False trails and genuine markers. *Child Development,* 62**,** 468-483.

STOKES, T. & BAER, D. 1977. An implicit technology of generalization. *Journal of Applied Behavior Analysis,* 10**,** 349-368.

STONE, W. 1998. Autism in infancy and early childhood. *In:* COHEN, D. & VOLKMAR, F. (eds.) *Handbook of autism and pervasive developmental disorders.* New York: Wiley & Sons.

STRICKLAND, D., MARCUS, L., MESIBOV, G. & HOGAN, K. 1996. Brief report: Two case studies using virtual reality as a learning tool for autistic children. *Journal of Autism and Developmental Disabilities,* 26**,** 651-659.

SWAGGART, B., GAGNON, E., BOCK, S. J., EARLES, T. L., QUINN, C. & MYLES, B. S. 1995. Using social stories to teach social and behavioral skills to children with autism. *Focus on Autistic Behavior,* 10**,** 1-16.

SWETTENHAM, J. 1996. Can children with autism be taught to understand false belief using computers? *Journal of Child Psychology and psychiatry,* 37**,** 157-165.

TAGER-FLUSBERG, H. 2000. Language and understandign minds: connections in autism. *In:* BARON-COHEN, S., TAGER-FLUSBERG, H. & COHEN, D. (eds.) *Understanding Other Minds: Perspectives from Developmental Cognitive Neuroscience.* London: Oxford University press.

TAN, J. 2000. Teaching children with autism social problem-solving skills through computer-assisted instruction. Academic Exerice, Dept. of Social Work & Psychology, National University of Singapore.

TARTARO, A. & CASSELL, J. Year. Playing with virtual peers: bootstrapping contingent discourse in children with autism. *In:* SCIENCES, I. C. O. T. L., ed., 2008.

TAYLOR, B., LEVIN, L. & JASPER, S. 1999. Increasing play-related statements in children wih autism toward their siblings: Effects of video modeling. *Journal of Developmental and Physical Disabilities,* 11.

THE-CHICI-GROUP. 2011. *Child Computer Interaction* [Online]. Available: http://www.chici.org/index.php/about-us [Accessed 3 Jan 2011].

THIEMANN, K. & GOLDSTEIN, H. 2001. Social stories, written text cues, and video feedback: effects on social communication of children with autism. *J Appl Behav Anal,* 34**,** 425.

THOMAS, N. & O'KANE, C. 1998. The ethics of participatory research with children. *Children & Society,* 12**,** 336-348.

THORP, D., STAHMER, A. & SCHREIBMAN, L. 1995. Effects of sociodramtic play training on children with autism. *Journal of Autism and Developmental Disorders,* 25**,** 265-281.

TOMASELLO, M. 1995. Joint attention as social cognition. *In:* MOORE, C. & DUNHAM, P. (eds.) *Joint Attention: It's origins and role in development.* Hillsdale, NJ: Lawrence Erlbaum Associates.

TRAVERS, K. 1997. Reducing inequities through particpatory research and community empowerment. *Health Education and Behaviour,* 24**,** 344-356.

TRAVIS, L., SIGMAN, M. & RUSKIN, E. 2001. Links between social understanding and social behaviour in verbally able children with autism. *Journal of Autism and Developmental Disorders,* 31**,** 119-129.

TREMBLAY, A., STRAIN, P., HENDRICKSON, J. & SHORES, R. 1981. Social interactions of normal preschool schildren. *Behavior Modification,* 5**,** 237-253.

TSE, J., STRULOVITCH, J., TAGALAKIS, V., MENG, L. & FOMBONNE, E. 2007. Social skills training for adolescents with Asperger Syndrome and High Functioning Autism. *Journal of Autism and Developmental Disorders,* 37**,** 1960-1968.

VAN DEN BOS, W., WESTENBERG, M. & VAN DIJK, E. 2010. Development of trust and reciprocity in adolescence. *Cognitive Development,* 25**,** 90-102.

VAN RIJN, H. & STAPPERS, P. 2008. Expressions of Ownership: Motivating Users in a Co-Design Process. *Proceedings Participatory Design Conference.*

VIERA, A. & GARRETT, J. 2005. Understanding the Interobserver Agreement: The Kappa Statistic. *Research Series - Family Medicine,* 37**,** 360-363.

VREDENBURG, K., MAO, J.-Y., SMITH, P. & CAREY, T. 2002. A Survey of User-Centered Design Practice. *CHI '02 Proceedings of the SIGCHI conference on Human factors in computing systems: Changing our world, changing ourselves***,** 471-478§.

WADSWORTH, Y. 1998. What is participatory action research? *Action Research International.*

WAKEFIELD, A. E. A. 1998. Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children. *The Lancet,* 351**,** 637-641.

WALLER, A., BALANDIN, S., O'MARA, D. & JUDSON, A. 2005a. Training AAC users in user-centred design. *Electronic Workshops in Computing Series.* Dundee, Scotland.

WALLER, A., BLACK, R., O'MARA, D., PAIN, H., RITCHIE, G. & MANURUNG, R. 2009. Evaluating the STANDUP Pun Generating Software with Children with Cerebral Palsy. *ACM Transactions on Accessible Computing,* 1.

WALLER, A., O'MARA, D., MANURUNG, R., PAIN, H. & RITCHIE, G. 2005b. Facilitating user feedback in the design of a novel joke generation system for people with severe communication impairment. *In:* SALVENDY, G. (ed.) *HCII 2005.* Nevada, Las Vegas, USA: Lawrence Erlbaum.

WALSH, G., DRUIN, A., GUHA, M., FOSS, E., GOLUB, E., HATLEY, L., BONSIGNORE, E. & FRANCKEL, S. 2010. Layered Elaboration: A Technique for Co-Design with Children. *CHI 2010.* Atlanta: ACM.

WELLMAN, H. 2002. Understanding the psychological world: Developing a Theory of Mind. *In:* GOSWAMI, U. (ed.) *Handbook of child cognitive development.* Oxford, England: Blackwell.

WELLMAN, H., HOLLANDER, M. & SCHULT, C. 1996. Young children's understanding of thought bubbles and of thoughts. *Child Development,* 67**,** 768-788.

WETHERBY, A. & PRIZANT, B. 1999. Enhancing language and communication development in autism: Assessment and intervention guidelines. *In:* ZAGER, D. (ed.) *Autism: Identification, education and treatment.* 2nd ed. Mahwah, NJ: Lawrence Erlbaum Associates.

WHALEN, C., LIDEN, L., INGERSOLL, B., DALLAIRE, E. & LIDEN, S. 2006. Positive behavioral changes associated with the use of computer-assisted instruction for young children. *Journal of Speech and Language Pathology and Applied Behavior Analysis,* 1**,** 11-26.

WHALEN, C., MASSARO, D. & FRANKE, L. 2009. Generalization in Computer-Assisted Intervention for Children with Autism Spectrum Disorders. *In:* WHALEN, C. (ed.) *Real Life, Real Progress for Children with Autism Spectrum Disorders: Strateges for Successful Generalization in Natural Environments.* Baltimore, MD: Brookes Publishing Company.

WHALEY, G., HOWSON, H. & WALLER, A. 2004. The development and evaluation of an electronic scheduler for young people with autism. *11th biennial conference for the International Society fro Augmentative and Alternative Communication.* Natal, Brazil.

WHO 1992. *International Classification of Diseases and Health Related Problems,* Edinburgh, Churchill Livingstone.

WILKINSON, L. 2010. *Best Practice Guide to Assessment and Intervention for Autism and Asperger Syndrome in Schools,* London, Jessica Kingsley Publishers.

WILLIAMS, C., WRIGHT, B., CALLAGHAN, G. & COUGHLAN, B. 2002. Do children with autism learn to read more readily by computer assisted instruction or traditional book methods?: A pilot study. *Autism,* 6**,** 71-91.

WILLIAMS, T. 1989. A Social Skills Group for Autistic Children. *Journal of Autism and Developmental Disorders,* 19**,** 143-155.

WIMMER, H. & PERNER, J. 1983. Beliefs abour beliefs: Representation and constraining function of wrong beliefs in young cildren's understanding of deception. *Cognition,* 13**,** 103-128.

WING, L. 2003. *The Autistic Spectrum, A Guide for Parents and Professionals* Robinson Publishing.

WING, L. & GOULD, J. 1979. Severe impairments of social interactions and associated abnormalities in children: epidemiology and classification. *Journal of Autism and Developmental Disorders,* 9**,** 11-29.

WOLF, M. 1978. Social validity: The case for subjective measurement or how applied behavior analysis is finding its heart. *Journal of Applied Behavior Analysis,* 11**,** 203-214.

WOLFBERG, P. & SCHULER, A. 1993. Integrated play groups: Promoting the social and cognitive dimensions of play in children with autism. *Journal of Autism and Developmental Disorders,* 23**,** 467-489.

WOOD, S. & ROMERO, P. 2010. User-centred Design for a Mobile Learning Application. *In Proceedings of the 3rd Mexican Workshop on Human Computer Interaction (MexIHC'2010).* San Luis Potosi, SLP, Mexico: Universidad Politcnia de San Luis Potosi.

WOODCOCK, A. & GEORGIOU, D. 2007. Project Spectrum; evoking, focusing and demanding action. *CoDesign,* 3**,** 145-157.

WOODCOCK, A., GEORGIOU, D., JACKSON, J. & WOOLNER, A. n.d. Designing a tailorable environment for children with autistic spectrum disorders. The Design Institute, Coventry School of Art and Design, Coventry University, UK.

WORTH, S. 2005. *Autistic Spectrum Disorders,* London, Continuum.

XU, D., READ, J., SIM, G. & MCMAUS, B. 2009. Experience It, Draw It, Rate It - Capture Children's Experiences with Their Drawings. *IDC 2009.* Como, Italy: ACM.

Appendix A. Design requirement specification

This appendix outlines the Design specification requirements, defined in collaboration with stakeholders and adhered to in the design and development of the software.

R1: Users of the sharing tool

1.1: Children with Autism Spectrum Conditions should be the primary users of the sharing tool.

Practitioners have identified this user group as having specific difficulties related to sharing.

1.2: Typically developing children may also be users of the sharing tool.

Children develop social skills at different rates and so users within this category may experience difficulties related to the development of sharing skills.

1.3: The sharing tool should be suitable for children with a developmental age of 4-7 years.

This is the age group targeted by the research.

R2: Customisation

2.1: There shall be a default theme consisting of (a) a background image of a garden, and (b) familiar objects that can be found in the classroom.

The user group should be familiar with the items contained in this default setting and so will not be unsettled by unfamiliar or unknown objects.

2.2: The sharing tool may include a customisation option for selecting a theme.

Selecting a preferred learning environment (theme) can increase user engagement with the system.

2.3: The sharing tool may allow the upload of specific images to represent the objects to be shared.

These images may be of specific interest to the user and so promote engagement with the sharing tool.

R3: Sharing scenario

3.1: The sharing tool shall focus on the "Division of Objects" and "Turn Taking".

Practitioners identified these areas as being the initial learning area for sharing.

3.2: The objects in the sharing tool should not fall within the special interests of the participants

Participants may be inclined to focus on repetitive behaviours related to the objects of special interest, and so are distracted from exploring sharing skills.

3.3: In early interactions with the sharing tool, participants shall share objects between generic animated characters.

The characters are representative of interaction with social partners.

3.4: In later interactions with the sharing tool, participants shall share objects between images of a peer and themselves.

The images are representative of possible social partners in reality.

3.5: The object being shared should be visible when being moved across the screen (*)

It can be confusing for participants if the default dragging logo is displayed rather than the object being shared.

R4: Character

4.1: The character should display consistent behaviour between scenes.

Children with Autism Spectrum Conditions can become unsettled by changes so ensuring consistency can alleviate anxiety.

4.2: The character should exhibit responses similar to those of social partners the child may interact with in reality.

By ensuring a resemblance of reality in the system, opportunities are presented to facilitate generalisation.

4.3: The character shall speak with a natural peer-aged voice.

Interacting with a peer is something that children with Autism Spectrum Conditions find difficult. This provides an opportunity to interact with peers in a non-threatening environment.

4.4: The character should speak using highly emotive and exaggerated tones.

Children with Autism Spectrum Conditions are more responsive to exaggerated emotions and behaviours.

4.5: Any instructions given by the character should be specific.

Ensuring that instructions are clear and specific ensures that there is no ambiguity and so reduces any possible social anxiety.

4.6: The character shall avoid the use of metaphors.

Children with Autism Spectrum Conditions are typically unable to understand the use of metaphors.

4.7: Animated gestures shall be simple, clear and functional.

When possible ambiguity is reduced, there is less chance that the users will experience stress or anxiety related to social comprehension.

4.8: The character shall impart only one piece of information or request at one time.

Children with Autism Spectrum Conditions find it difficult to process multiple pieces of information at once.

4.9: The character should allow the users time to process information given during interactions.

By slowing the interaction, users have the opportunity to process each piece of information at a pace that may be more suited to them than typical interactions they may experience in reality.

4.10: The character shall address users by using their name.

This increases engagement, and involves the child implicitly in the interaction.

R5: Bubbles

5.1: Bubbles shall be displayed on a plain background.

A plan background will avoid distractions from the main objects (the bubbles).

5.2: Bubbles shall move around the screen.

This reflects how bubbles behave in the real world.

5.3: Bubbles should merge when they collide.

This reflects how bubbles behave in the real world. It also allows the children possibilities to explore the different properties of bubbles.

5.4: The user shall be able to pop the bubbles.

This is a natural action to perform on the bubbles based on experiences in reality.

5.5: Larger bubbles should pop with a louder sound.

This is an outcome that the children can experience through exploration of the properties of bubbles.

5.6: Some bubbles (1 in 10) shall be displayed as a different colour.

This provides a change to the expectations that all bubbles will be the same, and provides an opportunity for exploration of the unexpected.

5.7: Popping the differently coloured bubble shall result in a different sound than popping.

This is different from expectations and allows opportunities for the child to explore the modality of sound.

R6: Structure

6.1: A within-task schedule shall be displayed in the sharing tool.

This is a crucial component of tasks and activities in reality. Including it directly in the sharing tool will add structure to the tasks.

6.2: The end-point of a task should be clearly indicated.

6.2(b): In bubbles tasks, a timer or countdown of how many bubbles can be popped should be displayed.

This reduces any anxiety resulting from an unexpected change.

6.2(a): In sharing tasks the end should be indicated by the appearance of bubbles.

This shows the progression from sharing to the bubbles scene. Using a timer in this situation is not acceptable as this may cause anxiety. Different children will accomplish the sharing task at different rates.

6.3: The sharing tool shall incorporate opportunities for reflection and emotional regulation.

Emotional regulation is crucial to learning, particularly for children with Autism Spectrum Conditions.

R7: Being in control

7.1: The sharing tool shall only move to the next task when the user is ready to do so.

Moving too quickly though the tasks will detract from learning and reflection on any knowledge gained.

7.2: The sharing tool should allow a provision for repeatable praise.

Repetition is a key emotional regulator for children with Autism Spectrum Disorders. This allows them to experience the joy of success on their own terms.

7.3: The sharing tool may include a help button that can invoke an adult involvement.

This can allow the child to initiate the involvement of an adult (as a portal for help) without the need for direct social interaction.

R8: Sensory experiences

8.1: The sharing tool should present opportunities for the user to engage with different modalities.

Different children will likely have a preference for different modalities, and will tailor their interactions to seek these.

8.2: The sharing tool shall not display bright colours or colour clashes.

Bright colours can be distracting for children with Autism Spectrum Conditions.

8.3: The sharing tool should utilise a reward structure with clearly indicated success.

This can provide a motivation for children to interact with the system and aim to complete tasks successfully.

Appendix B. Sample certificate of participation

This appendix comprises a sample certificate awarded to child participants in recognition of their participation in the research.

Appendix C. Peer interview instructions

This appendix shows the full contents of the peer interview instructions as was given to participants in the peer interview study outlined in Chapter Six.

How to use the camera

Turn the camera **on** using the button on the side.

To start filming press the red button.

Make sure the red writing appears on the screen.

To stop filming press the red button again.

The screen will say **Ready**.

Turn the camera **off** using the button on the side.

Interview Questions

1. What is your name?
2. How old are you?
3. We all share things every day. Can you tell me what sharing is?
4. Why is sharing important?

Think of a time when you had to share something with a friend...

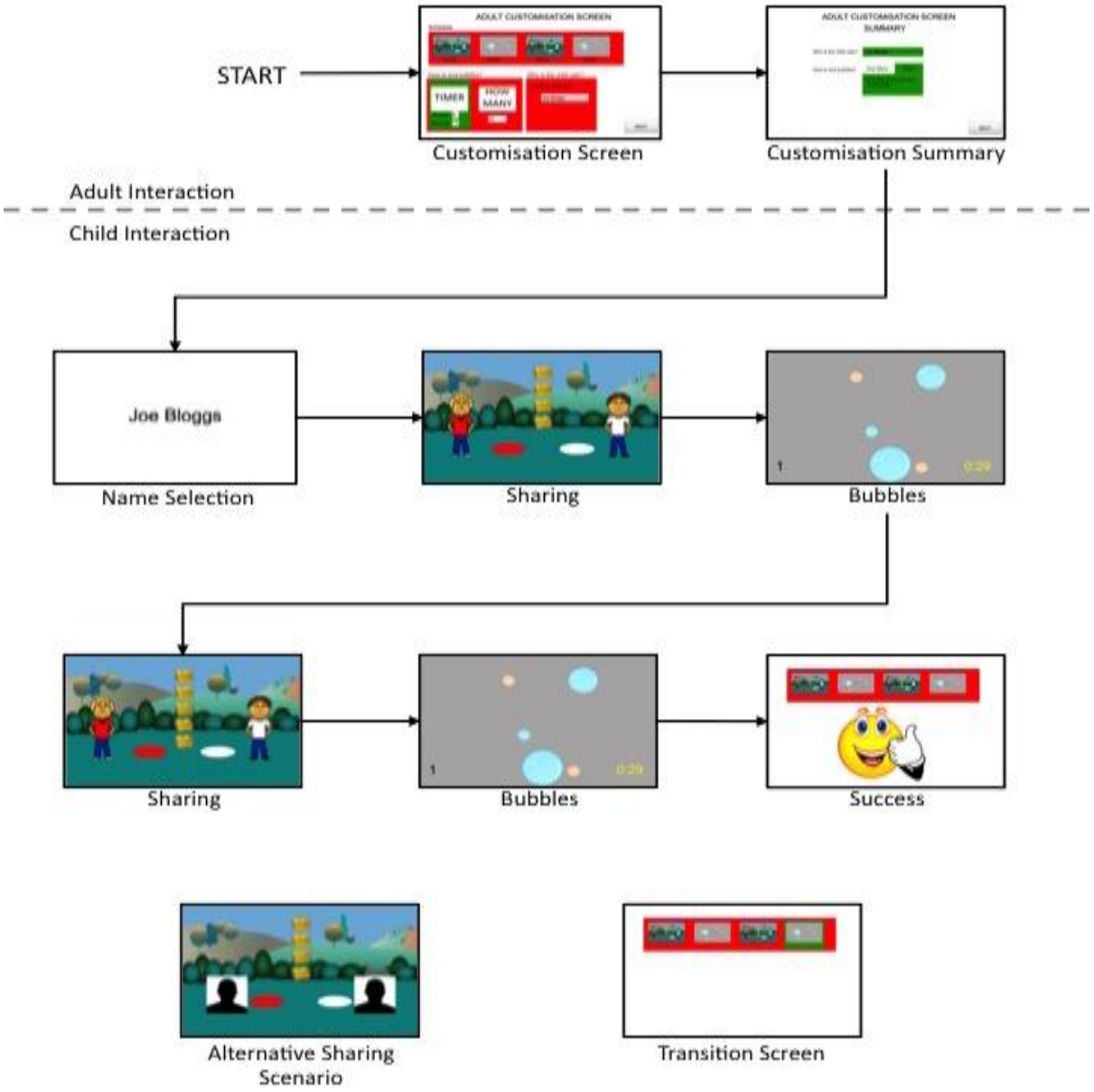
5. Who was there?
6. Where did it happen?
7. When did it happen?
8. Why did you have to share?
9. What happened?

10. Can you think of a time when sharing might not be a good idea?

Remember to turn the camera off when you are finished.

Appendix D. System walkthrough

This appendix shows the screenshots of a typical journey through the sharing tool.



Appendix E. Coding questions for sessions using software

This appendix outlines the Summary Values assigned to each video by coders. These values were assigned to all videos of the child participants using the sharing software system.

Q1: Indicate the quality of sharing behaviours you consider the child to have achieved in their interaction with the computer system.

(0) No success
(1) Limited success
(2) Success, but no social understanding
(3) Success

Q2: Indicate the level of support you consider the child to have required to use the screen in their interaction with the computer system.

(0) No support
(1) Occasional support
(2) Repeated support
(3) Dependent on support

Q3: Indicate the level of challenging behaviour you consider the child to have shown in their interaction with the computer system.

(0) No challenging behaviours
(1) Minor challenging behaviours
(2) Major challenging behaviours

Q4: Indicate the ability of the child to self-regulate (including emotional regulation) to use the computer system.

(0) Self-regulating without support
(1) Requires limited support
(2) Requires repeated support
(3) Dependent on support

Appendix F. Coding questions for baseline sessions

This appendix outlines the Summary Values assigned to each video by coders. These values were assigned to all videos of the child participants using the sharing software system.

Q1: Indicate the quality of the sharing behaviours seen.

(0) No sharing behaviours
(1) Limited quality
(2) Some high quality
(3) Many high quality

Q2: Indicate the level of challenging behaviour you consider the child to have shown during this session.

(3) No challenging behaviours
(4) Minor challenging behaviours
(5) Major challenging behaviours

Q3: Indicate the ability of the child to self-regulate (including emotional regulation) during this session.

(4) Self-regulating without support
(5) Requires limited support
(6) Requires repeated support
(7) Dependent on support

Appendix G. Information and consent pack for children with ASC

This appendix shows the information sheet, consent form and image release form for parents on behalf of their children with Autism Spectrum Conditions.

INFORMATION SHEET

ECHOES II

We invite you and your child to participate in a research project, conducted as part of research for the qualification of PhD. We believe it to be of potential importance. However, before you decide whether or not you wish to participate, we need to be sure that you understand firstly why we are doing it, and secondly what it would involve if you agreed. We are therefore providing you with the following information. Read it carefully and be sure to ask any questions you have, and, if you want, discuss it with outsiders. We will do our best to explain and to provide any further information you may ask for now or later. You do not have to make an immediate decision.

What is the ECHOES project?

ECHOES is a Technology Enhanced Learning (TEL) system to help children aged 5-7, both typically developing and those with Autistic Spectrum Disorders (ASD) or recognised difficulties in social skills, with their social communication and interaction skills. For children with ASD, social communication can be daunting and difficult, which may lead them to becoming socially isolated. Through using the Echoes system, we would hope that these children can develop a deep understanding of social communication and use this to become more socially networked as individuals.

It has been shown through research that social and communication skills are important for learning, which can mean that those children with ASD may be cut off from learning in ways that their typically developing peers are not.

What is the purpose of Echoes?

There are two main aims within the Echoes research:

1. To assist children of varying abilities in their exploration and learning of social interaction skills.
2. To develop a tool through which:
    a. Parents and practitioners (teachers and therapists) can examine the specific difficulties that children encounter in different situations, and
    b. Researchers can investigate the relationship between children's social skills, communication and learning.

Through the achievement of these aims, it is hoped that children will develop a deep understanding of social communication and interaction. This may lead to an improvement in their social abilities and have a positive impact on future life leading to adulthood.

School of Computing, College of Art & Design, Architecture, Engineering & Physical Sciences
UNIVERSITY OF DUNDEE Dundee DD1 4HN Scotland UK t +44 (0)1382 344145 f +44 (0)1382 345509

INFORMATION SHEET

Why has my child been invited to take part in the study?

Research shows that children with Autistic Spectrum Disorders and similar conditions can have severe difficulties in the area of social communication due to their problematic understanding of the social world around them. Even though your child may be progressing well in this area of their development, their teacher or speech and language therapist believes they will be capable of using the ECHOES system and would be able to help us evaluate our research.

Does my child have to take part in the study?

It is up to you to decide to join the study. We will describe the study and go through this information sheet with you. If you agree that your child can take part, we will then ask you to sign a consent form and image release form. We will also ask your child to agree (assent) to taking part in the study. You and your child will be given copies of these forms to keep.

What happens if I wish to withdraw my child from the study?

You are free to withdraw your child at any time, without giving a reason. Your child is also free to withdraw at any time without giving a reason. If your child does not want to take part, we will inform you, the teacher and therapist. Withdrawal from the study would not affect the standard of care or education you or your child receives.

If you decide to withdraw, identifiable data already collected with consent will be retained and used in the study. No further data will be collected or any other research procedures carried out.

What will my child have to do?

With your permission, we will access your child's medical records. The research team will access data concerning assessments and diagnosis, which will be used to avoid over-testing throughout the research. This means that your child will not have to repeat assessments already conducted as part of a diagnosis or assessment process.

Your child will be seen by researchers over the course of the research project (ending November 2011). Each session will be comprised of various activities and will be no longer than 60 minutes. The sessions will take place during school or at a time which is convenient for you.

The researchers will make the sessions as fun as possible so that your child will enjoy the experience. There will be a number of activities used such as arts & crafts, design activities, games, discussion groups and using prototypes of the new system being designed and developed. For example, your child may be asked to draw their favourite play location or participate in drama activities about sharing.

School of Computing, College of Art & Design, Architecture, Engineering & Physical Sciences
UNIVERSITY OF DUNDEE Dundee DD1 4HN Scotland UK t +44 (0)1382 344145 f +44 (0)1382 345509

INFORMATION SHEET

Sessions will be video-taped to allow the researchers to analyse the data afterwards. The aim of this research is not to "test" your child but to help us to see whether there is potential for the ECHOES system to support the development of social communication and interaction in children.

The sessions will be timetabled with the school to ensure that participating in this research does not have a detrimental effect on your child's education. In fact, we expect that participation will be useful for those involved, giving opportunities to improve social skills throughout the project.

What will I have to do?

We may also invite you to participate in a focus group as a parent or guardian. This will involve discussions of your child's development and their social abilities and strategies. Participation in focus groups is optional and it is possible for your child to participate without your involvement.

We will organise up to 4 focus group sessions or interviews spread throughout the project. Information shared during these focus groups should remain confidential between participants. This information will be used to inform the design of the ECHOES environment and may be used as part of our reports or dissemination of our research. This will always be used anonymously. No information that may identify an individual will be used for these purposes. These sessions will be video-taped to allow the researchers to analyse the data afterwards. The videos will be retained for the duration of the research project.

Refreshments will be provided. Should Focus Groups be conducted outwith the school environment, travel expenses will be reimbursed.

What are the possible disadvantages and risks of taking part?

Because your child may have difficulty in social communication skills, he/she may feel stressed or anxious during the sessions. To minimise the risks we will ensure that both testing and training sessions are as playful as possible with a focus on giving positive feedback for effort rather than correct answers. Should your child become tired or unsettled, the session will be stopped. The timing and location of sessions will be timed to avoid any negative impact on your child's schooling and ongoing speech and language therapy.

What are the possible benefits of taking part?

In our experience, children enjoy using new technology. They feel empowered by taking part in research when they realize that they are helping to develop a new technology. We cannot promise that the study will help your child, but your child's involvement will help us to understand how ECHOES can be used to support social communication and interaction.

School of Computing, College of Art & Design, Architecture, Engineering & Physical Sciences
UNIVERSITY OF DUNDEE Dundee DD1 4HN Scotland UK t +44 (0)1382 344145 f +44 (0)1382 345509

INFORMATION SHEET

Who can I contact in connection with this research?

If you have any queries or require further information, you can contact the researcher undertaking the study:

Name: Rachel Menzies
Address: Pod 2.03, Queen Mother Building
School of Computing
University of Dundee
Phone: (01382) 386540
Email: rachelmenzies@computing.dundee.ac.uk

If you would like to know more about this research and/or you have questions that cannot be answered by the researcher, please feel free to contact the Academic in charge at the institution:

Name: Dr Annalu Waller
Address: Pod 2.02, Queen Mother Building
School of Computing
University of Dundee
Phone: (01382) 388223
Email: awaller@computing.dundee.ac.uk

Thank you for taking the time to read this Information Sheet and for considering taking part in this study.

School of Computing, College of Art & Design, Architecture, Engineering & Physical Sciences
UNIVERSITY OF DUNDEE Dundee DD1 4HN Scotland UK t +44 (0)1382 344145 f +44 (0)1382 345509

CONSENT FORM

School of Computing
University of Dundee

ECHOES II

Name of Researcher: _____

		Please initial box
1.	I wish my child to be involved in this research project	☐
2.	I confirm that I have read and understand the information sheet (dated *4th August 2010* (*version 7*)) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	☐
3.	I understand that my child's participation is voluntary and that I am free to withdraw my child from the study at any time without giving any reason, without my or my child's medical care or legal rights being affected.	☐
4.	I understand that relevant sections of my child's medical notes and data collected during the study may be looked at by individuals from the research team or from NHS Tayside, where it is relevant to my taking part in this research. I give permission for these individuals to have access to records.	☐
5.	I understand that if my child is withdrawn from the research, any data collected to the time of withdrawal will be retained.	☐

_____ Name of Child	_____ Name of Parent/Guardian	
_____ Relationship to Child	_____ Signature	_____ Date
_____ Name of Person taking Consent	_____ Signature	_____ Date

When completed: 1 for participant; 1 for researcher site file.

School of Computing, College of Art & Design, Architecture, Engineering & Physical Sciences
UNIVERSITY OF DUNDEE Dundee DD1 4HN Scotland UK t +44 (0)1382 344145 f +44 (0)1382 345509

IMAGE RELEASE FORM

School of Computing
University of Dundee

ECHOES II

Name of Researcher: _____

	Please initial box
1. I confirm that I have discussed the release of video material and images of my child for the purpose of teaching and presentation.	☐
2. Initial one of the following statements:	
a) I am happy to release the images without pixelization.	☐
or b) I am happy to release the images as long as my child's face is pixelated.	☐
or c) I do not consent to the images being used for the purpose of teaching and presentation and wish for it to be destroyed after the study is completed.	☐

_____ _____
Name of Child Name of Parent/Guardian

_____ _____ _____
Relationship to Child Signature Date

_____ _____ _____
Name of Person taking Consent Signature Date

When completed: 1 for participant; 1 for researcher site file.

School of Computing, College of Art & Design, Architecture, Engineering & Physical Sciences
UNIVERSITY OF DUNDEE Dundee DD1 4HN Scotland UK t +44 (0)1382 344145 f +44 (0)1382 345509